R 1 1 1953

AMERICAN

Industrial Hygiene

ASSOCIATION

Quarterly

VOLUME 14, NUMBER 1
MARCH, 1953

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION

Officers, 1952-53

WILLIAM R. BRADLEY ..... President
American Cyanamid Company
30 Rockefeller Plaza, New York 20, New York

HENRY F. SMYTH, JR., PH.D. ..... President-Elect
Mellon Institute, 4400 Fifth Avenue
Pittsburgh 13, Pennsylvania

ANNA M. BAETJER, SC.D. ..... Past President
The Johns Hopkins School of Hygiene and Public Health
615 North Wolfe Street, Baltimore 5, Maryland

FREDERICK S. MALLETTE ..... Secretary
American Society of Mechanical Engineers
29 West 39th Street, New York 18, New York

LESTER V. CRALLEY, PH.D. ..... Treasurer
Aluminum Company of America
Pittsburgh 19, Pennsylvania

HENRY F. SMYTH, JR., PH.D. ..... Executive Secretary
Mellon Institute, 4400 Fifth Avenue
Pittsburgh 13, Pennsylvania

Board of Directors

ALLEN D. BRANDT, SC.D.
Bethlehem Steel Company

KARL L. DUNN
Corning Glass Works

LEONARD GREENBURG, M.D.
New York State Department of Labor

JAMES W. HAMMOND
Humble Oil & Refining Company

FRANCIS R. HOLDEN, PH.D.
U.S. Naval Radiological Defense Laboratory

W. G. HAZARD
Owens-Illinois Glass Company

C. H. MEHAFFEY
Mine Safety Appliances Company

KARL Z. MORGAN, PH.D.
Oak Ridge National Laboratory

J. C. RADCLIFFE
Ford Motor Company

THOMAS L. SHIPMAN, M.D.
Los Alamos Scientific Laboratory

JOSEPH F. TREON, PH.D.
Kettering Laboratory

HERBERT J. WEBER
American Brake Shoe Company

American Industrial Hygiene Association Quarterly

HERBERT T. WALWORTH ..... Editor
Lumbermens Mutual Casualty Company
4750 Sheridan Road, Chicago 40, Illinois

WILLIAM T. MCCORMICK ..... Associate Editor
The Inland Steel Company
3210 Watling Street, East Chicago, Indiana

HOWARD N. SCHULZ ..... Circulation Editor
Abbott Laboratories, North Chicago, Illinois

VINCENT J. CASTROP ..... Advertising Editor
General Motors Research Laboratory
485 West Milwaukee Avenue, Detroit 2, Michigan

JOHN M. KANE ..... Associate Advertising Editor
American Air Filter Company
215 Central Avenue, Louisville, Kentucky

WALTER F. SCHOLTZ ..... Associate Advertising Editor
Allis-Chalmers Manufacturing Company
1126 South 70th Street, West Allis, Wisconsin

BERNARD D. TEBBENS ..... Associate Advertising Editor
School of Public Health
University of California, Berkeley, California

WILLIAM F. WEBER ..... Associate Advertising Editor
11 La Salle Avenue, Cranford, New Jersey

AMERICAN
INDUSTRIAL HYGIENE
ASSOCIATION
Quarterly

Volume 14 MARCH, 1953 Number 1

MAXIMUM PERMISSIBLE DOSE FROM IONIZING RADIATION 15
Karl Z. Morgan, Ph.D.

A SIMPLE DEVISE FOR AIR ANALYSIS 23
J. B. Gisclard, J. H. Rook, W. V. Andresen and W. R. Bradley

A NEW EXPOSURE CHAMBER FOR INHALATION STUDIES 26
L. Baurmash, F. A. Bryan, R. W. Dickinson and W. C. Burke, Jr.

WHAT INDUSTRY EXPECTS OF THE OFFICIAL INDUSTRIAL HYGIENE AGENCIES 31
Louis E. Newman

SCIENTIFIC BOUNDARIES IN AIR POLLUTION STUDIES 35
W. C. L. Hemeon

THE EFFECTIVE CONTROL OF LEAD DUST IN THE MANUFACTURE OF VINYL PLASTICS 41
Alexander E. Goss and Arthur M. Ross, Jr.

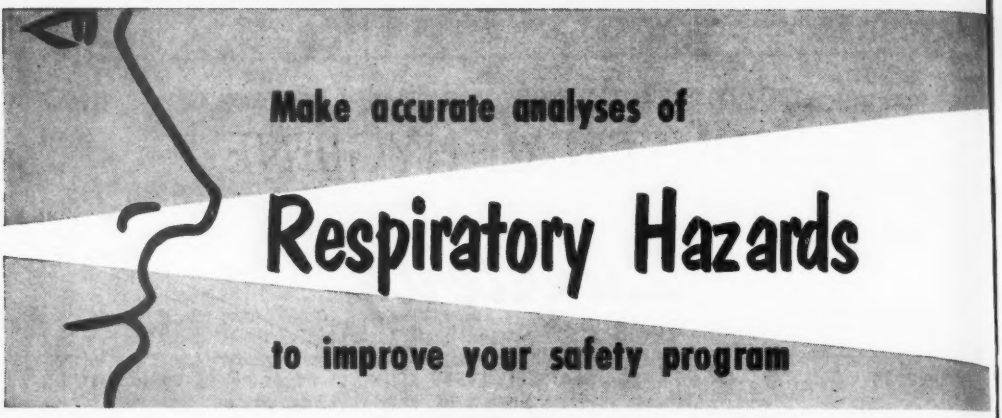
POLAROGRAPHIC METHOD FOR DETERMINING CHLORIDES IN AIR 50
Allen Guy and Lynn D. Wilson, Ph.D.

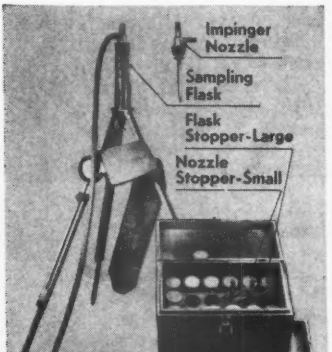
EAR PROTECTION IN INDUSTRIAL NOISE 54
D. E. Wheeler, Ph.D.

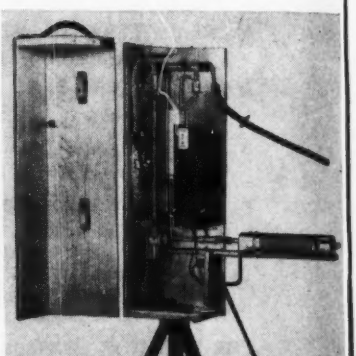
SAFETY STANDARDS FOR INDUSTRIAL NOISE 59
Stacy R. Guild

THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION
New Standing Committees 62
The President's Page 63
Annual Meeting 64
News of the Local Sections 66
Classified Column 70
Officers and Committees 71

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION QUARTERLY, published by the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION in March, June, September, and December. HERBERT T. WALWORTH, Editor; WILLIAM T. MCCORMICK, Associate Editor; VINCENT J. CASTROF, Advertising Editor; HOWARD N. SCHULZ, Circulation Editor; A. D. CLOUD, Publisher; DORIS FLOURNOY, Editorial Assistant. Publication, and Editorial Offices, 605 North Michigan Avenue, Chicago 11, Illinois. Subscription $2.00 per year in the United States; $2.50 per year in Canada; $3.00 per year in other countries. Single copies 75 cents. Copyright, 1952, The American Industrial Hygiene Association. Entered as second class matter May 3, 1948, at the post office at Sheboygan, Wis., under the Act of March 3, 1879.







IMPINGER DUST SAMPLING APPARATUS Used by the U. S. Public Health Service, State and City Health Depts., Insurance Companies, Mines, Smelters and Manufacturing Plants for determining the quantity of dusts which may cause pulmonary fibrosis. Available with either electric or compressed air suction apparatus as illustrated.

CHLORINATED HYDROCARBON SAMPLING APPARATUS For use by chemists or engineers in Departments of Health, Industrial Hygiene, Insurance Companies, Chemical Industries, Degreasing Plants, etc., for the determination of the concentration of chlorinated hydrocarbon vapors, such as trichloroethylene, chlorinated naphthalenes, and chlorinated diphenyl in the air.

Willson Air Sampling Equipment Eliminates Guesswork!

Approved apparatus developed by Willson detects the exact amount of dusts and vapors in the air your workers breathe. It establishes the degree of hazard surrounding various jobs. It makes it easy to determine the essential respiratory protection needed to maintain better health and reduce lost man-hours in your plant. By being sure of the hazards that exist, your safety program is made more effective.

Send for bulletin giving complete information

GOGGLES • RESPIRATORS • GAS MASKS • HELMETS

WILLSON®

"Established 1870"

WILLSON PRODUCTS, INC.

124 Thorn Street, Reading, Pennsylvania

Maximum Permissible Dose From Ionizing Radiation

KARL Z. MORGAN, Ph.D., Director
Health Physics Division, Oak Ridge National Laboratory
Oak Ridge, Tennessee

THE MAXIMUM permissible dose from ionizing radiation is not the maximum dose that is known or even believed to produce no radiation damage. Neither is it that dose of ionizing radiation that one should be encouraged to receive or strive to accumulate even for greater efficiency of operation. Perhaps for most types of energy, such as light, heat and sound, there is an optimum rate of absorption by man so that if the heat received is not adjusted properly, he is hot or cold, or a light may be too bright or dim, or a sound too low or loud for the optimum response of his senses and for his general well being. For these common sources of energy such as light, heat and sound man has developed senses that give a quick response and thus enable him to avoid extremes of exposure.

In spite of its prevalence, man's acquaintance with ionizing radiation only extends over an infinitesimal fraction of the many years of his evolution and development. Perhaps because man has not developed a sixth sense that responds to this type of radiation, there are still relatively few people who have studied these radiations and are able to detect and measure them, to determine whether they are alpha, beta, gamma or neutron and to assess the radiation hazards associated with them. Probably it is this lack of awareness and knowledge of ionizing radiation and the fact that some of the harmful effects of radiation require 15 to 20 years after the initial exposure to make their appearance that has caused some people to be careless and negligent, while others are overcautious and suffer from a case of radiation phobia. We should fear X rays, alpha, beta, gamma rays and neutrons no more than we fear electricity, but like electricity, ionizing radiation must be recognized as a source of energy that if properly understood and directed can contribute immensely to the advancement, comfort and happiness of man, but if improperly applied it can, and most certainly will, lead to suffering and disaster.

For some types of radiation damage there are threshold doses below which no effect is observed. For example, as indicated in Fig. 1, no fatalities are to be expected among men exposed to a total body dose of 200 roentgens of X or gamma radiation delivered in a single day and no radiation sickness is to be expected if this dose is less than 20 roentgens. These two threshold

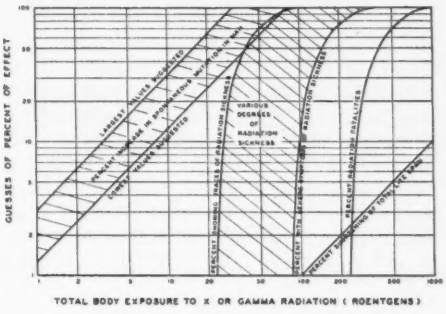

GUESSES OF PERCENT OF EFFECT
VARIOUS DEGREES OF RADIATION SICKNESS
TOTAL BODY EXPOSURE TO X OR GAMMA RADIATION (ROENTGENS)

Fig. 1.

Presented at the American Association for the Advancement of Science Meeting, Section on Medical Science, St. Louis, Missouri, December 30, 1952.

doses would be much higher if they were administered over a period of several days or weeks and/or if administered over a limited area of the body. Whereas radiation sickness and fatal exposure both require a threshold dose before the effect is observed, there are apparently some types of radiation damage, such as genetic mutations and shortening of the life span that may vary linearly with the dose somewhat as shown in Fig. 1. The present fragmentary evidence seems to imply that no dose is so small or distributed over so long a time but that it results in some damage. There are types of radiation damage, such as blood changes and tumor incidence, that are difficult to classify either as varying linearly with the dose or as having a threshold dose, because the effect becomes so small for the low doses that it is indistinguishable from the normal statistical variations of the same type. Probably all ionizing radiation produces damage to some cells of the body, but if the dose rate is so low that the rate of damage is less than the rate of repair of the body, the damaged cells are not likely to accumulate and result in serious consequences. However, this may not rule out the extremely low probability that a single damaged cell may become the precursor of further damage.

SINCE THERE is no dose or dose rate of ionizing radiation below which no biological change results, one might be tempted to set zero as the maximum permissible dose. However, this would be not only unreasonable and ridiculous but impossible to attain since man is always subjected to the so-called background radiation from cosmic rays, gamma radiation from the radium products in the soil, and in the food, water and air he takes into his body and from the natural body burden of K^{40}, C^{14}, and uranium, thorium and their daughter products. This dose rate of approximately 0.4 mrep per day from natural sources may vary by a factor of two depending upon geographical location or natural radiation environment. Since one is unable to detect any over-all damage to man as a result of this background radiation—man has managed to improve through the ages in spite of the radiation if not because of it—it does not seem reasonable to establish a maximum permissible dose rate of ionizing radiation at a value equal to (or even close to) the natural background dose rate.

The principal maximum permissible dose rate for adults* widely agreed upon is the 0.3 rep** per week of X or gamma radiation to the blood-forming organs, and for convenience in measurement this is taken to mean all tissue that is five or more cm below the surface of the body. This value was applied specifically to the blood-forming organs since they are considered to be among the more radio-sensitive body organs and the ones most likely to receive damage from total body exposure to ionizing radiation. Because there are other organs of the body closer to the surface than five cm which may be equally radiosensitive (such as the eyes and gonads) and because there is need for simplification in monitoring procedures and in dose calculations, this dose rate of 0.3 rem per week is commonly applied as the maximum permissible dose rate to any body organ and is furthermore applied to the working areas.† Table I lists the 0.3 rep per week and other equivalent exposure rates agreed upon at the Chalk River and London Conferences on radiation protection. Where the exposure is limited to the hands and forearms and especially for the case of beta radiation, the value of 0.3 rem per week may be increased by a factor of five as indicated in the last column of Table I.

It is *not* claimed that this value of 0.3 rem per week produces no biological changes. Rather this is a dose rate that an adult may average over a period of two or three months at a time for many years without producing any detectable damage. The biological damage that may be expected to result under these conditions is not con-

*This is the principal value upon which the other maximum permissible exposure values are based and that was adopted at the Chalk River Conference, September 1949, and the London Conference, July 1950 (National Bureau of Standards Handbook 47).

**The rep or roentgen equivalent physical corresponds to an ionizing energy absorption of 93 ergs per gram of tissue. The rem or roentgen equivalent man is that amount of ionizing radiation which produces the same damage to man as one roentgen of X radiation. (1 rem = 1 rep/RBE in which RBE is the relative biological effectiveness of the radiation.)

†It was suggested at the Chalk River and London Conferences that this value of 0.3 rep per week be increased to 0.5 rep per week for measurements made outside the body where body scattering is included. Actually this introduces an unnecessary refinement and monitoring complication which is seldom applied.

TABLE I.
MAXIMUM PERMISSIBLE TISSUE DOSE LIMITS

Type of Radiation	Maximum Permissible Exposure to Blood-Forming Organs (rep/wk)	(rem/wk)	RBE*	In the Basal Layer of the Epidermis: Exposure of Entire Body (rep/wk)	Exposure of Hands Only (rep/wk)
X or Gamma	0.3	0.3	1	0.5	1.5
Beta	0.3	0.3	1	0.5	1.5
Thermal Neutron	0.06**	0.3	5**	0.1**	0.3**
Proton or Fast Neutron	0.03	0.3	10	0.05	0.15
Alpha	0.015	0.3	20	0.025	0.075

*RBE = Relative Biological Effectiveness.

**The relative biological effectiveness (RBE) and roentgen equivalent physical (rep) values used for thermal neutrons in these tables are only approximate and have questionable meaning. Flux values are more precise in that they are determined by treating separately the protons and gamma rays, that result from thermal neutrons, and adding the contributions of each after weighting them properly.

sidered to be greater than the damage from many common and willingly accepted everyday hazards, such as overeating and smoky cities. If this 0.3 rem per week were received on the average each week for 40 years, this would add up to 624 rem. This exposure would lead to biological changes although the person that accumulated this exposure would find it difficult or impossible to point to any particular body change and attribute it to this radiation exposure. We do not know what radiation damage 624 reps of X or gamma radiation or its equivalent of other types of ionizing radiation received by the total body over a period of 40 years would produce in man, but using animal experiments as an indication we might expect (1) a shortening of the average expected life span,[1] (2) an increase in the mutation rate by a factor of 10 to 20 above the natural or spontaneous rate[2] if this exposure were received by all members of the population prior to the termination of childbearing, (3) and possibly an increased probability of other biological changes. Although the National Committee on Radiation Protection has agreed on the 0.3 rem per week as discussed previously, it does not propose establishing a maximum permissible accumulated lifetime exposure. In fact, one can question the desirability or efficacy of establishing such a limit until more substantial biological information is available. In order to stimulate the reader to consider this matter, however, the writer might suggest a value of about 150 rem, which corresponds to an average of about 0.3 rem per week over a period of 10 years. Since many persons may intend to work with sources of ionizing radiation over a period greater than 10 years and since there is a possibility of a considerable non-occupational exposure to ionizing radiation (chest and dental X-ray, shoe fitting machines, etc.), it is evident that one should strive to average occupational exposures much less than 0.3 rem per week. These considerations have been kept in mind at the various Atomic Energy Commission supported laboratories where the average exposure of most persons working with radioactive material is only a small fraction of the 0.3 rem per week. Table II indicates the average exposure of personnel at the Oak Ridge National Laboratory over the past few years.

TABLE II.
AVERAGE WEEKLY EXPOSURE (MREM/WEEK) OF ORNL PERSONNEL OVER SIX MONTH PERIODS

Period of Exposure	Average of All Laboratory Personnel Liable to Exposure (All That Wear Film Meters) (mrem/wk)	Average of All Persons Participating in the Reactor, Accelerator, and/or Experimental Physics Programs (mrem/wk)	Average of All Persons Participating in Experimental Chemistry and/or Chemical Engineering Programs (mrem/wk)	Average of All Persons Participating in the Production of Radioisotopes (mrem/wk)
1/1/50-6/30/50	11	4	44	73
6/30/50-1/1/51	11	6	22	75
1/1/51-6/30/51	10	5	11	73
6/30/51-1/1/52	11	4	16	96
1/1/52-6/30/52	17	5	44	138

IN ADDITION to maximum permissible dose from external sources of ionizing radiation, one is often concerned with sources of ionizing radiation that become fixed inside the body as foreign elements incorporated as parts of the living cells of his body. These internal sources of ionizing radiation or "body burdens of radioisotopes" as they are commonly called, gain entrance into the body by inhalation, ingestion, through cuts and abrasions or directly through the pores of the skin. The National Committee on Radiation Protection has prepared a handbook[3] dealing with problems of internal dose. This handbook lists maximum permissible body burdens and the corresponding maximum permissible concentrations in air and water of some 70 radioisotopes.

In determining the maximum permissible body burden and maximum permissible concentration in air and water of radioisotopes that behave chemically like radium, it is possible to make use of the 25 years of experience man has had with radium, but most of the radioisotopes can be expected to behave quite differently from radium and thus comparisons with radium cannot be made. In a few cases there have been accidents where radioisotopes were taken into the body and limited body distribution and excretion data have been obtained. Usually one must rely upon animal experimentation to determine the initial retention, distribution among the body organs, rate of excretion and biological damage, and then after making usual assumptions one extrapolates this data to man.

In determining the maximum permissible concentrations of radioisotopes in air, water and food, one first estimates the initial retention and deposition in the critical body organ. This depends not only upon the radioelement but upon the chemical form (soluble, insoluble, etc.), the physical state (liquid, solid, gas, size particle, etc.), the method of body intake, and rate of metabolism. Since specific information in general is lacking for a particular radioisotope, the best available data is used for estimating this factor of retention and deposition for both the soluble and insoluble compounds of the radioisotope. For the 70 radioisotopes listed in the handbook on internal dose this factor in the case of ingestion (fraction of that ingested that is deposited in the critical body organ) ranges in magnitude from 10^{-5} to 1.0. If the material is inhaled, it has been assumed rather arbitrarily in this handbook that 12% of the insoluble material is retained in the lower respiratory tract, and that 25% of the soluble material is initially adsorbed from the lung, and 50% of the inhaled soluble material is swallowed. These values depend on many factors, some of which are listed above, and, when specific information for a particular isotope is available, refinements can be made in the general data given in the handbook.[3] The fraction retained at the site of an open wound or absorbed through the skin and translocated to the critical body organ usually has to be estimated from the conditions incident to the accident, from measurements made with probe counters in the wound and from blood and urine analyses.

THE CRITICAL body organ referred to above is that organ of the body receiving the radioisotope that results in the greatest damage to the entire body. It is usually the organ having the greatest concentration, but not always since some body organs are more radio-sensitive than others. It is usually the body organ receiving the greatest damage, but this may not always be the case since some body organs are more essential to the proper functioning of the body than others. Further, the critical body organ may change depending upon the time after exposure at which the body damage is considered. For chronic exposures the critical body organ is likely to be that body organ in which the radioisotope has the longest biological half-life.

Having selected the critical body organ and determined the fraction, f, of the radioisotope taken into the body that arrives at the critical organ, it remains to find the effective half-life of the radioisotope in the critical organ. This is given by the equation

$$T_e = \frac{T_b \, T_r}{T_b + T_r} \qquad (1)$$

in which T_e = effective half-life, T_b = biological half-life, and T_r = radioactive half-life. This assumes that the amount of a radioisotope in the critical organ at any time is given by a single exponential equa-

tion. Actually during the early period following a single intake of a radioisotope at time t = 0, the amount present in the total body at any later time t can best be expressed by the sum of a number of exponential terms,

$$I = I_1 e^{-0.693t/T_1} + I_2 e^{-0.693t/T_2} + \ldots + I_c e^{-0.693t/Tc} \quad (2)$$

In the somewhat oversimplified picture,* each term of this equation represents the amount of the isotope present in a given body organ at any time t, thus at time t = 0 the total amount present in the body will be given by the equation: $I_o = I_1 + I_2 + \ldots + I_c$. The effective half-lives of the radioisotope in the various body organs are given by T_1, T_2, etc., and T_c is the effective half-life in the critical organ. Usually for the chronic exposure T_c is much larger than T_1, T_2, etc. The fractions of the radioisotope that initially go to the various organs are given by I_1/I_o, I_2/I_o, I_c/I_o, etc.

Equation 2 can be written in the form,

$$I = \frac{I_c}{f_c} e^{-0.693t/T_c} = \frac{f\,I_o}{f_c} e^{-0.693t/T_c} \quad (3)$$

in which $I f_c = \mu c$ of the radioisotope in critical organ at any time, t, $I_o = \mu c$ originally taken into the body in a single event, f = fraction of that initially taken into the body that arrives at the critical organ, T_c = effective half-life of the radioisotope in the critical organ, and f_c = fraction in critical organ of that in total body at time t.

The maximum permissible concentrations of a radioisotope in air, $(MPC)_a$, and in water, $(MPC)_w$, as given in the handbook on internal dose, apply to the case where the radioisotope is taken continuously into the body over a long period of time and are obtained by integrating the equation

$\frac{d(I f_c)}{dt} + \lambda I f_c = C f r$ from 0 to t. This gives

$$(MPC) = \frac{3 a q f_c}{T_c f (1 - e^{-0.693t/Tc})} \quad (4)$$

in which $C = \mu c$/cc of water or air that will result in a deposition of I microcuries in the total body or $I f_c$ microcuries in the critical organ in time t. When the dose rate in the critical organ reaches the maximum permissible value of 0.3 rem/wk in time t, the concentration C is said to be the maximum permissible concentration or C = (MPC) for the period of exposure t and the total body burden is q microcuries or I = q. For large values of t/T_c a condition of equilibrium is reached in which the rate of intake of the radioisotope is equal to the rate of elimination and the burden in the critical organ, $I f_c$ (or $q f_c$ when the dose rate in the critical organ is 0.3 rem/wk) remains constant as long as the exposure continues. The rate of intake of air (2×10^7 cc/day) or of water (2,200 cc/day) is given by r; the decay constant, $\lambda = 0.693/T_c$; and a is a constant whose value is 10^{-8} for air or 10^{-4} for water.

The maximum permissible body burden, q, is given by the equation,

$$q = \frac{2.6 \times 10^{-3}\, m\, W}{E f_c (RBE)} \quad (5)$$

in which m = mass of critical body organ in grams; W = 0.3 rem per week; E = effective energy of the radiation in Mev per disintegration emitted by the radioisotope, and RBE is the relative biological effectiveness of the radiation as given in Table I.

Table III gives values for $(MPC)_w$, $(MPC)_a$ and q for some of the more common radioisotopes as listed in the handbook on internal dose.[3]

IN MOST CASES the MPC values listed refer to the equilibrium condition, and usually this condition is reached in a period, t, of a few days or months. Of the 70 radioisotopes considered in the handbook all reach equilibrium in less than 20 years with the exception of Pu^{239}, Sm^{151}, Ra^{226}, and Sr^{90}. Fig. 2 indicates the manner in which the dose rate to the critical body organ increases with time if water which is contaminated with the radioisotope at a concentration as calculated by equation four is used exclusively for a time, t. In this case Pu^{239} has reached only 34% of equilib-

*Equation 2 frequently is not a good representation of the amount of the radioisotope in the various body organs because the radioisotope may be translocated from one body organ to the other and the half-lives are often a function of time t. However, this method of calculation is usually not applied except to chronic exposure, and in this case T_c is sufficiently constant so that equation 3 gives good results.

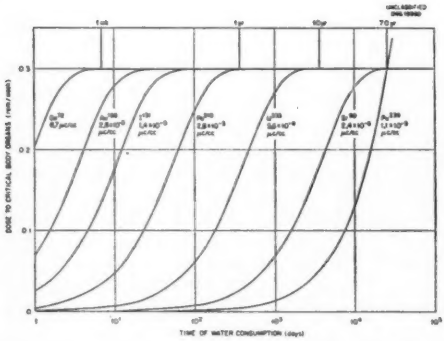


Fig. 2.
Showing the increase in dose rate to the critical organ when drinking water is contaminated with radioisotopes at concentrations as indicated on on each curve.

rium in the 70 year period—the maximum value of time, t, used in the calculation of MPC values as given in the handbook.

It sometimes happens in the event of an accident or for some other reason we are concerned with a single exposure rather than with the continuous consumption of radioisotopes, as was assumed in obtaining the values in Table III. In this case one may integrate equation three from time 0 to t and supply the proper constants to obtain the equation for dose,

$$D = \frac{80\ E\ f\ I_o\ T_c\ (RBE)\ (1 - e^{-0.693t/T_e})}{m} \quad (6)$$

in which D is the dose in rem delivered to the critical organ in time t days when I_o μc are taken into the body and the fraction, f, is deposited in the critical organ. The effective half-life (in days) and energy (in Mev) are given by T_e and E, respectively.

Emergencies or accidents may lead to unavoidable internal doses from radioisotopes, but it is suggested by the writer that in ordinary emergencies considerable effort should be taken to maintain the dose, D, as given by the above equation at less than 20 rem for t = one day, 30 rem for one week (t = 7), or 60 rem for one month (t = 30). In extreme emergencies—where saving of life is involved or operations essential to national defense—the writer suggests values of D should not be greater than five times the above values. In making these single dose calculations it should

TABLE III.

Element	Critical Organ (gm)	q (μc)	$(MPC)_w$ (μc/cc)	$(MPC)_a$ (μc/cc)
$Ra^{226} + \frac{1}{2}$ daughters	Bone 7×10^3	0.1*	4×10^{-9}	8×10^{-12}*
Rn^{222} + daughters	Body 7×10^4 Lungs 10^3	—	2×10^{-6}	10^{-8}*
Pu^{239} (soluble)	Bone 7×10^3	0.04*	1.5×10^{-6}*	2×10^{-12}*
Pu^{239} (insoluble)	Lungs 10^3	0.008	—	2×10^{-12}*
Po^{210} (soluble)	Spleen 150	0.02	3×10^{-5}	2×10^{-10}
Po^{210} (insoluble)	Lungs 10^3	7×10^{-3}	—	7×10^{-11}
	Fat 10^4	250	3×10^{-3}	10^{-6}
C^{14} (CO_2)	Bone 7×10^3	1500	4×10^{-3}	5×10^{-7}
H^3 (HTO or H^3_2O)	Total Body 7×10^4	10^4	0.2	2×10^{-5}
Ca^{45}	Bone 7×10^3	65	5×10^{-4}	3×10^{-8}
P^{32}	Bone 7×10^3	10	2×10^{-4}*	1×10^{-7}
K^{42}	Muscle 3×10^4	20	1×10^{-2}	2×10^{-6}
S^{35}	Skin 2×10^3	100	5×10^{-3}	10^{-6}
Na^{24}	Total Body 7×10^4	15	8×10^{-3}	2×10^{-6}
Cl^{36}	Total Body 7×10^4	200	2×10^{-3}	4×10^{-7}
Fe^{55}	Blood 5×10^3	1×10^3	4×10^{-3}	6×10^{-7}
Fe^{59}	Blood 5×10^3	11	1×10^{-4}	1.5×10^{-8}
I^{131}	Thyroid 20	0.3	3×10^{-5}	3×10^{-9}
Sr^{89}	Bone 7×10^3	2*	7×10^{-5}*	2×10^{-8}*
$Sr^{90} + Y^{90}$	Bone 7×10^3	1*	8×10^{-7}*	2×10^{-10}
Co^{60}	Liver 1.7×10^3	3	2×10^{-3}	10^{-6}
Au^{198}	Kidneys 300	10	3×10^{-3}	1×10^{-7}
Au^{199}	Kidneys 300	28	7×10^{-3}	2.5×10^{-7}
Un β, γ**	Any organ	—	10^{-7}	10^{-9}
Un α**	Any organ	—	10^{-7}	5×10^{-12}

*Values obtained by comparing with radium standard and not by use of equations 4 and 5.
**Values for unidentified mixtures of radioisotopes that are beta or gamma emitters (Un β, γ) or alpha emitters (Un α) that are safe to use for a few months until the radioisotopes can be identified.

be recalled that the critical organ may change from day to day as indicated previously by equation two, and the migration of the radioisotope from one body organ to the other may give a very complicated dose picture. During the early period the lungs (for an inhalation accident), GI tract (for an ingestion accident), or wound site (for contaminated wound) are the critical organs. For somewhat longer periods of time the kidneys and liver may be the critical organs, and for extended periods the bone is frequently the critical organ.

In any case, whether one is concerned with a radiation accident or day-to-day radiation monitoring, the elimination of the radioisotope from the body should be checked by frequent chemical analyses of urine (and/or fecal analysis) and this together with a study of external exposure data should aid in estimating the day-to-day dose rates in the various body organs. Also, it must be remembered that normally there will be more than one radioisotope involved and frequently there is an external radiation dose that must be added to the internal dose. An attempt should be made to sum all these exposures and determine the total rem dose to each body organ over various time intervals.

In the calculation of the MPC and q values as outlined above it must have occurred to the reader that even if all the terms given in equations four and five were known accurately, there still would be many factors of uncertainty. Some of these factors of uncertainty are listed below with a + or − sign attached to indicate whether they would tend to increase or decrease respectively the MPC values.

1. It was assumed that the radioisotope becomes uniformly distributed in the critical organ. Actually there is uneven deposition. This correction can be made to the calculated values if and when experimental data is available (−).

2. Limited body exposure, i.e., exposure confined largely to a single body organ, is known in general to be less harmful than total body exposure (+).

3. Insoluble dust particles containing radioactive contamination would tend to give a very high tissue dose close to the particle (probably −).

4. Factors of selective absorption in a stream of water may lead to increased or decreased concentration at the point of human consumption relative to the MPC values at the point of discharge into the stream (− or +).

5. The MPC values are based on continuous exposure 24 hours a day, seven days a week until a dose rate to the critical organ of 0.3 rem/wk is reached under equilibrium conditions (or for a period of 70 years in the case of Pu^{239}, Sm^{151}, and Ra^{226}). It is unlikely that many exposures will be continuous (+).

It is because of these and other factors of uncertainty—especially the uncertainty in the experimental values substituted in equations four and five—that all unnecessary contamination of air and water should be avoided and the body burden of the various radioisotopes should be kept to a minimum. The internal dose handbook adds a word of caution, "Bearing in mind that in the future it may become necessary to lower some permissible limits, it is suggested that a factor of safety that may be as large as ten be used in the design and operation of permanent installations where large quantities of radioactive material are involved."

IN SPITE of the uncertainties, it is believed that the values given in the handbook should be extremely useful since they probably represent the best values possible in light of our present knowledge, and these values will be revised frequently as more information becomes available. Realizing that many people are now working with radioisotopes and are faced with the problems of handling them and of their disposal, it is wise to select the best value available at the present time for external and internal exposure to ionizing radiations —even though they be in error. The values selected are considered to be safe for the present; to lower them appreciably would lead to excessive costs in the atomic energy industry; to raise them too high would lead to radiation damage and eventually to higher costs. Only long time studies on animals and observations on man will enable us to adjust the maximum permissible exposure to external and internal sources of ionizing radiation to the proper value. The determination of the maximum permissible

dose to ionizing radiation and the estimation of the fraction of this dose a person who is working with radioisotopes has received, presents many problems and offers great opportunity for research in this relatively new field of Health Physics.[4] The need and opportunity for graduate students to take training in this field has already been pointed out. Likewise many institutions employing personnel working with ionizing radiation have discovered that they can solve many of these problems, contribute to their solution, or even avoid some of them by employing health physicists with adequate training and experience. Radiation protection is one of the most important and expensive requirements that must be adequately met if atomic energy is to continue its advance and find a permanent place as one of our leading industries.

References

1. BOCHE, ROBERT D., MDDC-204: Observations on Populations of Animals Exposed to Chronic Roentgen Radiation; BLAIR, H. A., UR-206: A Formulation of the Injury, Life Span, Dose Relations for Ionizing Radiations, I. Application to the Mouse; UR-207: A Formulation of the Injury, Life Span, Dose Relations for Ionizing Radiations, II. Application to the Guinea Pig, Rat and Dog.

2. PLOUGH, H. H.: Radiation Tolerances and Genetic Effects. *Nucleonics*, 10:8, August, 1952.

3. "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water," Publication of the National Committee on Radiation Protection, U.S. Bureau of Standards Handbook 52; Superintendent of Documents, Washington 25, D.C.

4. ANDERSON, E. E.: The Education and Training of Health Physicists. *Amer. Jour. of Physics*, 20:6 (September) 1952.

M.I.T. Noise Reduction Program

A SPECIAL summer program on *Noise Reduction*, to be taught by PROFESSOR LEO L. BERANEK with assistance from the Acoustics Laboratory Staff, is being offered at the Massachusetts Institute of Technology, August 24 through September 4, 1953. The course will deal with the essentials of, and criteria for, noise control in buildings, machines, and enclosures. Approximately half of the time will be spent in the discussion of principles of noise and vibration reduction and in demonstrations. The remaining time will be used for field trips. Throughout the course, week ends and some half days will be free for personal activities so that the course may be combined with a vacation. Assistance will be rendered wives in finding interesting things to do in the greater Boston area. Low cost dormitory facilities and cafeteria service for individuals or couples will be available. For further information write to: Director of the Summer Session, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

A Simple Device for Air Analysis

J. B. GISCLARD, J. H. ROOK, W. V. ANDRESEN and W. R. BRADLEY
Industrial Hygiene Section, Central Medical Department
American Cyanamid Company, New York, New York

CONVENTIONAL methods of atmospheric sampling and analysis of gases usually consist of scrubbing the air to be tested through a selective absorbing liquid for a determined period of time and then analyzing the solution.

A variation of this procedure lies in an "air titration" method whereby the air to be tested is drawn through a selective absorbing solution containing an indicator until a color change takes place. By noting the volume of air required to effect this color change a calculation can be made on the spot as to the concentration of gas present. Such a procedure has been described for the determination of sulfur dioxide in the atmosphere.[1]

From the industrial hygiene standpoint we have found that, depending on conditions, such "on the spot" information is often preferable to longer period sampling for the following reasons: (1) In contrast to the average values obtained by long period sampling, peak concentrations associated with hazardous conditions are noted at once. (2) Where extensive coverage is important, more representative analyses can be made in a given period of time. (3) Data is obtainable where laboratory facilities are not readily accessible. (4) A minimum of equipment is required.

Experiencing the need for a versatile, portable device which would expedite such sampling, we have developed and used for a number of years a simple apparatus which might be described as a spot sampler. The success which we have had in using the device has prompted us to describe it here for the benefit of those who might be seeking such methods and types of apparatus.

The device ready for use is shown in Fig. 1. It consists of a 100 cc syringe mounted on a 2½" x 12" x ¾" plywood board by means of bronze clips. A small hole is drilled 2" from the end of the board to accommodate a T tube of any convenient size with one arm bent as shown and connected to the tip of the syringe by means of rubber tubing. The back panel board consists of a piece of plywood 4" x 5" x ¼" with a 1½" x 1¼" x ¼" base nailed at the bottom. A small hole is drilled through the base and the plywood board to take a small bolt and wing nut which secures and holds the panel upright as shown. Two side arm test tubes are mounted on the panel

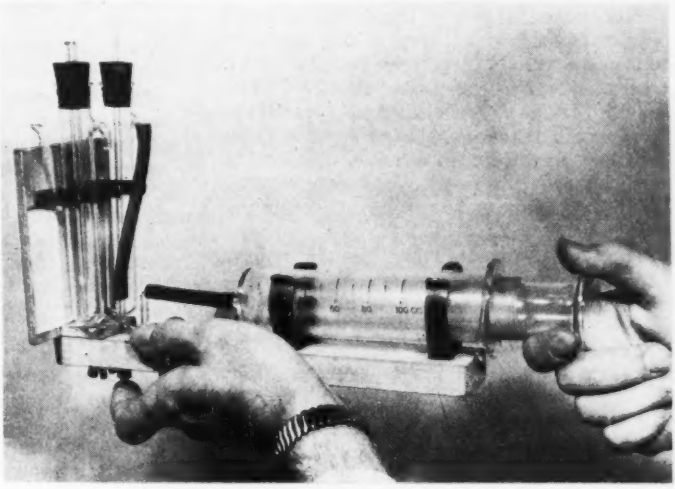


Fig. 1.

by means of metal clips. The inlets of the test tube consist of a piece of 5 mm O.D. pyrex tubing 6½" long drawn to a 2 mm opening at the bottom and inserted through a No. 2 one-hole rubber stopper.

In operation, 10 ml of the absorbing liquid is placed in the tube and, holding the device in the left hand, the left index finger is placed over the opening of the T Tube. The plunger is then pulled at a rate of about 100 cc per 30 seconds until the 100 cc mark is reached. The index finger is removed and the air expelled from the syringe by pushing the plunger to its original position. The aspiration is repeated until the end point is reached and the volume of air recorded. Since the amount of contaminant required to react with the quantity of absorbing solution is known by calculation, this amount is present in the volume of air scrubbed. Further calculation reveals it in terms of parts per million.

The device has been successfully used for testing industrial atmospheres for ammonia, sulfur dioxide, hydrogen sulfide, and hydrogen cyanide. It has also been used for collecting samples of other atmospheric constituents such as formaldehyde and alcohol for subsequent laboratory analysis. It has been especially useful for testing the "Airfluent" of vent stacks for ammonia, sulfur dioxide and hydrogen sulfide. In this case, stronger solutions must, of course, be employed.

The successful use of the device is based on the utilization of very dilute standard solutions which therefore require small volumes of air to effect color changes. Testing the device for efficiency is superfluous because the reagents selected for the gases described have been in common use for the same purpose for many years and warrant the use of almost any type of scrubbing device.

The procedures described below are those which have been satisfactory for field use.

Sulfur Dioxide

Reagents:

1. .0001 N Iodine (1 ml = .0032 mg. Sulfur Dioxide).
2. Fresh starch solution.

Procedure:

Pipette exactly 10 ml of the iodine into a side arm test tube, add a drop of starch and scrub the air containing sulfur dioxide through the solution until the blue color is discharged. Record the volume and calculate the concentration of sulfur dioxide present using the following formula:

$$\frac{10 \times .0032 \times 24{,}450}{\text{Vol. of air in liters} \times \text{Mol. Wt. of } SO_2} = \text{PPM}$$

Example: Assume 1500 cc of air required:

$$\textit{Then: } \frac{10 \times .0032 \times 24{,}450}{1.5 \times 64} = 8 \text{ PPM}$$

Hydrogen Sulfide

Reagents:

1. .0001 N Iodine (1 ml = .0017 mg. Hydrogen Sulfide).
2. Fresh starch solution.

Procedure:

Proceed in the same manner as for Sulfur Dioxide. Record the volume and calculate the concentration of sulfur dioxide present using the following formula:

$$\frac{10 \times .0017 \times 24{,}450}{\text{Vol. of air in liters} \times \text{Mol. Wt. of } H_2S.} = \text{PPM}$$

Ammonia

Reagents:

1. .0001 N Sulfuric acid (1 ml. = .0017 mg. ammonia).
2. Methyl Purple Indicator.

Procedure:

Pipette exactly 10 ml. of the acid into a side arm test tube, add a drop of indicator and scrub the air containing ammonia through the solution until the purple color changes to green. Record the volume and calculate the concentration of ammonia present using the following formula:

$$\frac{10 \times .0017 \times 24{,}450}{\text{Vol. of air in liters} \times \text{Mol. Wt. of } NH_3} = \text{PPM}$$

Hydrogen Cyanide

The procedure used for hydrogen cyanide is the one described by White.[2] In this case, we use the syringe assembly instead of the rubber bulb used by White because of increased accuracy in reading the volume of air required to match the colors.

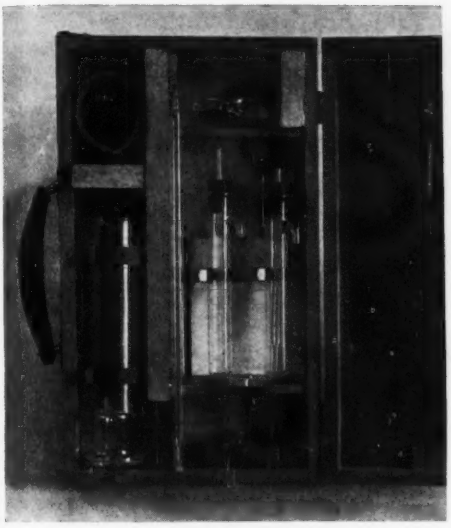


Fig. 2.

On occasions, where the end point is not sharp because of low concentrations of gas being present there is an accuracy compensation which exists between volume of air required for a good end point and concentration of reagent used. An example can be given in the case of the determination of sulfur-dioxide using dilute standard iodine. If the concentration of sulfur dioxide in the atmosphere is 8 PPM then by calculation 1500 cc of air is required to decolorize 10 ml of .0001 N iodine. A deviation of 100 cc more or less from 1500 cc gives answers of 7.6 and 8.7 PPM respectively.

This deviation is of no consequence when it is considered that the practical significance of air sampling is the indication of a range of concentrations which might exist during a working period and to which employee exposure might occur.

Fig. 2 shows how the device can be mounted in a small carrying case. Since distilled water is usually available .1N solutions can be carried in sealed ampoules for further dilutions, and indicators can be placed in screw capped vials.

References

1. PEARCE, S. J. and SCHRENK, H. H.: The Determination of Sulfur Dioxide in Air by Means of the Midget Impinger. U.S. Bureau of Mines, Report of Investigation 4282, May 1948.

2. WHITE, NORMAN G.: Hydrogen Cyanide as an Industrial Hazard Methods of Detection and Control. *American Industrial Hygiene Association Quarterly.* 9:81, 1948.

W.C.L. Hemeon Honored

ON JANUARY 22, 1953, the Junior Chamber of Commerce of Pittsburgh, Pennsylvania sponsored a dinner at which BENJAMIN F. FAIRLESS was acclaimed Pittsburgh's man-of-the-year. At the same time, W. C. L. HEMEON, Engineering Director of the Industrial Hygiene Foundation was accorded recognition for outstanding contributions in air pollution abatement, industrial dust control and ventilation. The honor was the 1953 Science Award which is given annually for outstanding contributions in the science field.

A New Exposure Chamber for Inhalation Studies

L. BAURMASH, F. A. BRYAN, R. W. DICKINSON and W. C. BURKE, JR.
Division of Industrial Medicine, Department of Internal Medicine
School of Medicine, University of California at Los Angeles

An inhalation chamber of new design has been developed for use in the study of the effect of air-borne contaminants. The chamber is designed for ease of animal handling, chamber cleaning, and decontamination. The unit is also of such design that there are no "dead" spots in the chamber.

The feed maintains a uniform concentration with a maximum of 4.3% variation. The concentration can be varied to meet the requirements of the experiment.

Although the chamber was not originally developed for use in radioactive contaminant study, its design readily allows active materials to be used.

PREVIOUS STUDIES on the inhalation of solid aerosols involved the use of large chambers in which statistically significant numbers of animals could be exposed to the same concentrations at the same time. These chambers were usually square or rectangular and because of this configuration the concentration in the units was not uniform throughout the total volume.

The development of an exposure unit was undertaken in which a quantity of animals could be exposed to the same concentration regardless of the location of the animal. A theoretical consideration of the problem would indicate that all the animals should be at the same distance from the source of contamination. Thus a solution of this problem would require a circular chamber with the contaminated air entering the chamber somewhere along the central axis. In order to eliminate the possibility of variations in the concentration along radial lines, the position of the animals should be changed during exposure time so that each animal is exposed to the total volume. Ease of cleaning and decontamination was also a major consideration in design.

This paper was based on work performed under Contract AT-04-1-GEN-12 between the United States Atomic Energy Commission and the University of California at Los Angeles.

Construction of Inhalation Chamber

A CIRCULAR CHAMBER of about 6½ feet in diameter with an elliptical vertical cross section was designed with the view in mind of eliminating all corners and dead air spaces (See Fig. 1). The chamber proper was fabricated of fiber glass and plastic laminations in two halves. In the upper half there is a Lucite door, a Lucite window, and a continuous Lucite band eight inches wide around the lower edge. The lower half is similar except that there are no windows or doors, and its upper edge is modified to receive a rubber sealing gasket. The upper half may be lifted up from the lower half by means of a small block and tackle attached to the ceiling of the room. The fact that the upper half may be lifted greatly facilitates cleaning of the chamber and loading of animal cages. A circular sheet metal platform which acts as the supporting table for the animal cages is placed at a point approximately midway between the top and bottom of the chamber. This metal table is revolved slowly in order that any variations in radial air flow may be minimized.

The dust from the feeder enters the chamber through a pipe at the bottom cen-

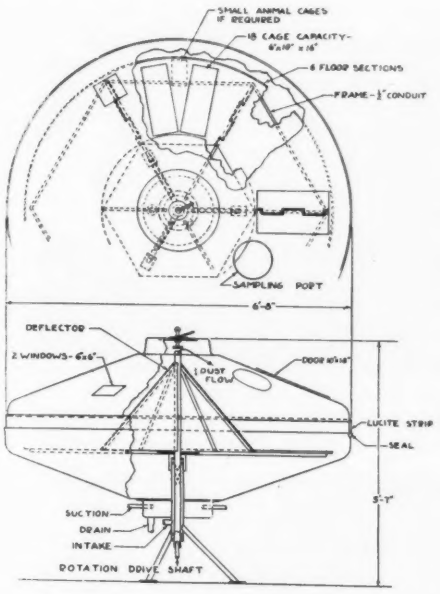


Fig. 1.
Schematic diagram of inhalation chamber.

ter. It then travels upward to a point near the top of the chamber, where it is deflected outward and downward. There are air ports located in the top of the chamber, and the air pouring in through these ports efficiently mixes and diffuses the dust throughout the chamber volume. The normal air flow pattern through the chamber is from the upper center, down and outward over the platform, and then down and into the center under the platform. The air exits from the chamber at four ports near the bottom center.

The four exit ports from the chamber merge into a three inch diameter duct, and this duct is connected to the inlet side of a centrifugal blower. There is a bypass valve located at this point and manipulation of this valve controls the air flow rate through the chamber. The blower exhausts through a fiber glass filter and the exhaust from this filter in turn passes through a sub-micron filter to the outside air.

Efforts were made to obtain even distribution of dust laden air throughout the chamber but especially at the outer rim of the table where the heads of the animals would be located. This was accomplished by: (a) restricting the flow of incoming air by an adjustable deflector plate at the top of the chamber to obtain an "umbrella" effect; (b) restricting the air flow slightly at the rim of the table; and (c) locating a multiple-outlet manifold on the bottom cap for removal of air. The chamber is operated at slightly below atmospheric pressure to avoid leakage and is sealed on all joints to prevent air from leaking into the chamber and thus diluting the desired concentration of dust. Test holes were supplied around the upper cap and around the chamber at table level. An added precaution against the possibility of uneven concentrations of dust or possible 'channelling' within the chamber was to rotate the table at 1/60 RPM.

The unit was constructed of three major assemblies: (1) rotating assembly consisting of motor and reducer, feed tube, table and deflector; (2) support assembly consisting of tripod base, guide tube and intake stub; and (3) chamber assembly comprised of upper half and cap, lower half and sump, with suction manifold and drain.

Assembly one drive is by a ¼ HP motor through a vertical output shaft reduction gear which takes the weight of the rotating parts. The feed tube is plugged and bored at the bottom to accommodate the drive shaft. It is well perforated between the bearings of the guide tube so as to permit dust laden air to pass from surrounding annulus to inside the feed tube.

The table frame is of strong but light construction resting on two collars welded to the feed tube; it is covered with interchangeable segments of galvanized iron and the deflector cone is of the same material.

Assembly two is a welded assembly of steel tubing, the vertical length having a bearing at top and bottom and supported by three legs with bases suitable for attachment to the floor. The vertical piece has a stub welded on for the dust-air mixture to enter the equipment, and a collar on the outside which takes the weight of the chamber proper.

In Assembly three, the chamber halves, cap and sump are of formed fibre-glass cloth bonded with Laminac (American Cyanamid Company). Plaster forms were made, one for the cap and sump and an-

other for a 120° segment of the chamber, from which six parts were made and later the joints were scarfed and bonded to complete the circles. The chamber form was underscored to form the inner portion of the seal on the lower half of the chamber. The lower part only of the form was used for the outer strip of the seal, attached separately, and the underscored portion was cut off entirely for the upper half of the chamber so as to form a vertical edge to which sheet Lucite could be attached. If it is planned to flush feces from the chamber by means of a water stream, the drain should be connected to a large sewer line. If catch pans are placed beneath the exposure cages, a small diameter sewer line could be used.

Fig. 2-A.
View of inhalation chamber showing relative positions of feed, control panel and chamber.

Dust Feeder

THE DUST concentration within the chamber is controlled by regulating the air flow through the chamber and by means of a dust feed device. The dust feed device is one manufactured by the Farr Company of Los Angeles, and it is known as the "Far-Air Model 4 Dust Feeder." (See Fig. 2-B.)

This dust feeder consists of a tray with four parallel grooves running the length of the tray. Four brushes rotate in the grooves with their plane of rotation in the direction of the grooves. The tray moves from right to left, and the brushes rotate in a clockwise manner. Located at the bottom of each groove in such a position that the brushes must sweep into them are four stationary aspirating tubes. On one side of the tray is a gear rack which engages a pinion gear driven by a small synchronous motor. Another synchronous motor drives the brushes. Pins located on the rotating element of the brush drive actuate a mechanism that taps the aspirating tubes. This action ensures that the tubes remain open.

To load the tray with dust, the tray is removed from the feeder. A weighed portion of dust is spread to an even depth in the grooves between two marks on the tray. These marks are 24 inches apart. The dust concentration in the chamber is controlled by the number of grooves used and the amount of material in the grooves. One load will last twelve hours.

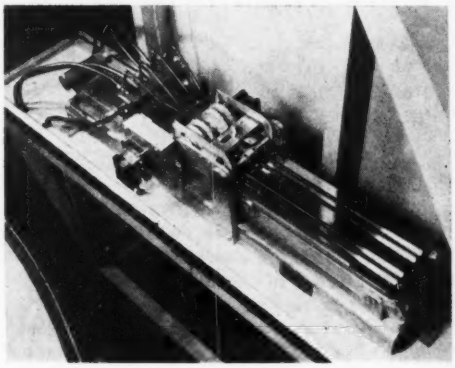


Fig. 2-B.
Top view of dust feeder.

The air supply for the aspirating tubes is at 50 pounds per square inch gage. The dust picked up by the tubes is carried in four copper tubes to a mixing chamber. The four separate streams there merge into one stream, which is then fed into the inhalation chamber.

A cover fits over the entire dust feed unit. A section of the cover is made of Lucite, and it is removable for easy access to the feed mechanism and removal of the feed tray for loading. The cover has an air-tight seal around its base where it is secured to the table holding the dust feeder. So that air may enter the cover to furnish the needs of the aspirating tubes, two three-inch diameter felt filters are installed in

the cover. In case of a stoppage in the tubes, a blow-back might occur; and these filters would remove any dust from the air leaving the cover by the filters.

In the event of a shutdown of the chamber exhaust blower, the air stream from the dust feeder would continue to feed into the chamber. Hence, the dust would continue to be fed into the chamber, and would expose the experimental animals to concentrations of dust above that which they would inhale if the equipment were operating normally. In order to prevent this, a solenoid switch, in parallel with the electrical connections to the chamber exhaust fan, is placed in the compressed air line leading to the dust feeder. If the power to the exhaust fan should fail, the solenoid would prevent the continued flow of dust into the chamber.

Calibration

SILICA was chosen as the material with which to conduct the calibration runs on the chamber. This material is most nearly like the dust that will be used in later experiments, and it is available in good supply. A quantity of silica that had been sieved through a 325 mesh screen was obtained, and a portion of this sufficient for the necessary calibration runs was put through an air elutriator to separate the 0 to 10 micron diameter particles. The 0 to 10 micron fraction was used as the dust feed material.

As the dust feeder is set up in our laboratory, the groove nearest the front of the dust feeder was designated as number one groove, then the next was number two, etc. When one groove only is to be used to contain dust, number one groove is always used. When two grooves are to be used, then grooves one and two filled, etc. All calibration work was done using this system to eliminate the possible differences due to feed characteristics of the various aspirating tubes.

The system followed, therefore, for all calibration work was to weigh an amount of silica and spread it in the number one groove between the two markings on the tray. A series of runs were made. The same amount of dust was then spread in each of grooves one and two, and the runs were made. This process was continued until all four grooves had been used, and then the process was continued using another amount of material to spread in the grooves. It was found that the concentration range of most interest could be covered by putting 2, 4, 6, 8, or 10 grams of dust in one or more grooves.

A run consisted of charging the dust feeder with the desired amount of dust, and feeding it into the chamber. The exhaust blower was operated to draw 205 cubic feet of air per minute at standard temperature and pressure through the chamber. The rotating platform was not used during most of the calibration tests. An air sampling device using a 9 cm diameter filter paper was used to withdraw a sample of the air within the chamber over a thirty minute period of time. A rotometer and manometer were in the air line of the air sampler. From these instruments the amount of air flowing through the filter was known for each run. Since the filter paper was weighed before the test, the gain of weight was due to dust filtered from the air.

It was found that the weighing procedure involving the filter papers could be greatly simplified by the use of a dry box. Originally it was planned to dry the filter papers before each weighing, and then rapidly weigh them on a balance. The filter papers presented such a great surface area, however, that accurate weighing was difficult. A dry box large enough to contain the beam balance was then designed. The balance along with a quantity of silica gel were placed inside the box, and the door of the box was closed. The door contained a large glass window through which observations were made, and a pair of long rubber gloves extending into the box made it possible to carry out the weighing procedures without opening the box.

At the completion of a series of calibration runs, the filter papers were placed inside the box along with fresh ones for the next day's work. The next morning the used and the new papers were weighed. In this manner errors due to absorbed moisture were practically eliminated from the weighing process, and weighing could be carried out at a more leisurely pace.

To determine whether or not dead air spaces existed and to get some idea of the

actual air flow in the chamber, the rotating platform was covered with paper; and a zinc-cadmium sulfide phosphor was used as the dust which was fed into the chamber. Light from an ultra-violet lamp was then played upon the paper. The distribution of the zinc-cadmium sulfide dust could then easily be studied, and hence the dust distribution in the chamber and the air flow patterns could be studied. It was found by this means that the dust distribution was quite uniform, and that no dead air spaces were in evidence.

To further substantiate the evenness of the dust distribution, samples of dust were taken with the air sampling device placed on the rotating platform. Samples were taken as the platform rotated in the chamber. The difference in weight between the dust samples collected in this manner was within the normal difference in weight of the dust samples collected at the same dust concentrations during the calibration runs.

An orifice is located in the exhaust duct between the chamber and the exhaust blower. There is a manometer measuring the pressure drop across this orifice, and it was necessary to calibrate this manometer to measure air flow in the duct. This was done by inserting the wand of an Agitair flow meter into the duct upstream of the orifice plate, and measuring the flow rates at a point in the center of the duct and near the duct wall for several different air flow rates through the duct. The air flow rates through the chamber were regulated by means of the by-pass valve at the intake of the blower.

The synchronous motor driving the dust tray was changed from one with an output velocity of one revolution per minute to one having an output velocity of one-half revolution per minute. The former motor ran the tray at a rate requiring six hours for a load of dust, while the latter requires twelve hours. Calibration work using both of these motors was done.

The data obtained, using the one RPM motor, shows wide variation ranging from 5% to 15%. The concentrations using the one-half RPM motor show less variation and these data are given below:

Dust Loading	Avg. Dust Concentration, mg/ft³	% Variation
4 g, groove 1	0.0785, ± 0.0025	3.2
4 g, grooves 1, 2	0.1115, ± 0.0025	2.2
4 g, grooves 1, 2, 3	0.1633, ± 0.0005	0.3
4 g, grooves 1, 2, 3, 4	0.1935 ± 0.0055	2.8
6 g, groove 1	0.1160, ± 0.0050	4.3
6 g, grooves 1, 2	0.1610, ± 0.0010	0.6
6 g, grooves 1, 2, 3	0.2130, ± 0.0070	3.3
6 g, grooves 1, 2, 3, 4	0.2915, ± 0.0035	1.2
8 g, groove 1	0.1280, ± 0.0010	0.8
8 g, grooves 1, 2	0.1850, ± 0.0030	1.6
8 g, grooves 1, 2, 3	0.2585, ± 0.0015	0.6
8 g, grooves 1, 2, 3, 4	0.3485, ± 0.0055	1.6

From these data it is clear that the slower tray speed produces more uniform dust concentrations in the chamber.

Summary

THE USE of the rotating platform in a circular chamber permits the exposure of a number of experimental animals to the same concentration during time of exposure.

There are no "dead" locations in the chamber relative to the concentration. There are no possible leaks inherent in the design of the chamber since it is operated under a negative pressure at all times. The chamber is readily available for cleaning and decontamination.

The concentration in the chamber can be regulated for various loading effects by varying the weight of material placed in the feeder. The concentration, once set, does not vary much from the average; and this is very advantageous in that a long-time run can be made at a given concentration.

Although the chamber was not specifically designed for the use of radioactive materials in inhalation studies, it lends itself readily to this work through the ease of cleaning and decontamination.

What Industry Expects

of the official industrial hygiene agencies

LOUIS E. NEWMAN, Manager
Health and Safety Services Department
General Electric Company, New York City

THERE IS NO substitute for competent people sincerely trying to do a job whether the job is a public one or a private one. It is important that the job be a useful one, and that those trying to do it be sufficiently free of political or other pressure to do an unbiased job. So, in setting down what industry expects of its official industrial hygiene agencies, let's discuss first the need for such agencies, then what is expected of them, and lastly how they might better be able to perform their tasks.

Need

MOST OF US will accept as fact that there is a need for public agencies of industrial hygiene. Management in private industry has the prime responsibility for preserving the health and safety of its workers, but often through ignorance, and sometimes through carelessness, it is unaware of job environments that adversely affect the health, productivity, or morale of its workers. Often, too, those most needing advice in industrial hygiene are least aware of their need for advice.

Major examples of mass occurrences of occupational diseases in various industries were the famous radium painting cases at the time of the First World War in the watch industry; the cases of beryllium poisoning in the fluorescent lamp industry following the Second World War; and the cases of silicosis in the mining and foundry industries that have required persistent attention over many years. Within the past ten years many of the larger industries have been developing their own industrial hygiene services, and it seems likely that this trend will continue. Such services, however, require highly trained men and are too costly for many small industries. In these smaller industries, unable to provide their own industrial hygiene services, exists the greatest need for public industrial hygiene agencies.

Another type of need sometimes arises when management and employee differ on the degree of a hazard and earnestly seek the advice of a competent unbiased third party. Public hygiene agencies can be a valuable source of such advice, and should set standards to serve as guides for the future. The agency thus can sometimes serve as arbitrator, even though its efforts are fact-finding rather than judicial. Afterwards, its report will provide an official record of its findings.

Sometimes the result of a check of suspected toxicological conditions turns up a totally unexpected answer. In a recent case, for example, two second shift welders had become ill and carbon monoxide seemed to be the cause. Tests were made early the following morning, but no carbon monoxide was found and all control devices were working satisfactorily. The industrial hygienist's report concluded with this laconic statement: "A possible solution was found when it was learned that the two men had cooked and eaten a bucket of clams over the heating unit."

What Is Expected

RESPONSIBILITY for acceptable industrial health, hygiene and safety rests on the shoulders of operating management. Public agencies should be available to operating management and to its employees for advice and counsel, but responsibility for

Originally published in the March, 1953 issue of the *American Journal of Public Health.*

correction should remain with operating management. However, if the official agency has a record of unbiased advice from competent staffs their recommendations will soon gather the force of law.

An example comes to mind of a tragic accident in which a man was burned to death while removing accumulations of paint with a highly flammable cleaner. His clothes became saturated and he struck a spark with a protruding nail in the heel of his shoe that set fire to his clothing. The resulting burns caused his death. The plant management sought advice on absolute prevention of a future accident of this sort. Complete protective asbestos clothing with oxygen mask would provide "absolute" protection from a future accident of this sort, but it is unlikely that any industrial hygienist would recommend so extreme a remedy. Actually, a much less flammable cleaner was found, better ventilation was easily available, and it was recommended that the worker wear boots. This solution was economical, safe, and acceptable to the worker. Public agencies must make recommendations that are not only technically sound, but economically sound if they are to hold the confidence of industry.

So far, much stress has been placed on competent staffs giving unbiased advice. The reason for this is that a public agency of industrial hygiene has a responsibility to labor, a responsibility to management, and a responsibility to the general public. These are equal responsibilities.

In most states industrial hygiene is part of the Department of Public Health. In New York, Massachusetts, and Illinois, industrial hygiene is part of the Department of Labor. Industrial hygiene overlaps areas in the fields of public health, safety, and industrial relations. Note, however, that the significant thing is not to what it is attached, but that it be free to give unbiased advice.

Bearing in mind that public hygiene agencies can achieve their objectives better by giving sound technical advice in a persuasive manner, rather than by acting the role of a regulatory body, certain standards of service become of special importance. These are:

Availability: Special care should be taken to see that when called upon for advice that it is given speedily, or the request for advice is turned down. Speed, quality, and quantity should be in proper balance. Service, however, can be overdone, so judgment should be exercised in expanding the size of the agencies' staffs. Perhaps a staff can be expected to operate best when it is so overloaded with requests for its services that it must use careful discrimination to choose only those projects that most need its help. Then it will not be tempted to write long reports on queries that might better be answered in a sentence or two.

Uniformity: Special care should be taken to see that public agencies, State and Federal, interchange information with the objective not only of keeping informed, but also of promoting uniformity of advice. The official agencies should provide or accept uniform standards. These should apply particularly to such things as threshold limits, sampling methods, and ventilation design. The current situation where the threshold limit recommended by one State may vary by several hundred percent from those of another State is confusing. It is hard to understand, for example, why a concentration of 250 PPM of alcohol is harmful in Kentucky but not in California. The threshold limit values recommended yearly by the American Conference of Governmental Industrial Hygienists is an excellent example of a step in the right direction.

Accuracy: Special care should be taken to see that a fair, mature evaluation of conditions is made. This evaluation should be based on sufficient technical data, or on years of mellowed experience with similar problems. Industry realizes that the current state of knowledge often makes a completely accurate evaluation impossible, with the result that the industrial hygienist leans toward the safe side. This is as it should be; but the "lean" should be in the order of ten degrees, not one hundred and eighty degrees.

Clarity: Special care should be used to make recommendations in language understandable to a layman. Industrial hygiene is a new field with terms and concepts unfamiliar to the layman who often must use the hygienist's report as a basis for action. In a recent report, for example, the average lead concentration given was 0.14 milligram

per cubic meter of air. This was followed by a statement that the MAC (and this was not defined in the report as meaning Maximum Allowable Concentration) for lead was 0.15 mg per cubic meter. Even though the lead concentration was less than the stated limit the report recommended an exhaust ventilation system.

Later, in the same report, a carbon monoxide concentration was given as 200 PPM (and this was not defined as meaning parts per million by volume). Then the report gave the Maximum Allowable Concentration for carbon monoxide as 100 but approved the condition.

The report did not make clear why a lead concentration that appeared to be within safe limits was unsafe, whereas a carbon monoxide concentration that was above the Maximum Allowable Concentration was reported as safe. After some inquiry it developed that the lead concentration represented a continuous exposure that would probably increase in time; the carbon monoxide exposure was a very short, infrequent exposure. The conclusions and recommendations of the report were valid, but it took a skilled hygienist to interpret the report. The best report in the world is valueless if the man who must use it can't understand it.

Practicality: Special care should be taken to see that recommendations are sensible, practical, and economical. Industry must make a profit to survive, and unnecessarily expensive control measures can seriously hamper obtaining a fair profit. In one small industry, for example, an air agitated chromic acid tank (not a plating tank) was producing an excessive amount of chromic acid mist. The industrial hygienist recommended an exhaust system which would have cost the owner between six and seven hundred dollars. The owner of this small business was financially hard-pressed at the time and explained his predicament to the inspector. The industrial hygienist then suggested trying plastic bubbles such as are used on plating tanks. These were obtained at a cost of about twenty dollars and are giving adequate control. Control measures are often an unexpected expense that may work a hardship on a business. Recommendations should make sense from an economic standpoint.

Palatability: Special care should be taken to see that recommendations are couched in persuasive language. Much important advice will be resisted if care isn't taken to be sure that the advice fits the case and is understood by the participants.

Tact: Special care should be taken to conduct an investigation in a manner to allay needless fears. While representatives of a public agency are working in a plant they should remember that the employees are curious and possibly suspicious. It may take only a careless word, even if said in a joking manner, to excite or worry the employees. Representatives from a public agency coming into a plant have a special responsibility to try to improve relations between the employees and their management.

Balance: Special care should be taken to see that the minimum unit set-up has proper balance in the fields of medicine, engineering and chemistry. Later, other more specialized fields can be added such as health-physics, bio-statistics, nutrition, and others. Because of the group skills required, it is desirable that the agency have all of its members located sufficiently near each other to promote close communication and cooperation.

How Accomplish Objectives

CLEARLY DEFINED areas of responsibility help assure that jobs that need doing are done, and that large areas are not overlooked. To this end Federal and State agencies should avoid unnecessary overlap by agreeing on their relative areas of responsibility. It is recommended, for example, that Federal agencies concern themselves primarily with mass studies of industries and groups; with the broad research into the pathology and toxicity of things beyond the facilities and scope of the State agencies; with establishing standards for guidance of State and other agencies; with correlating the activities of different States' activities where correlation is necessary.

The State agencies should provide services for evaluating hazards; should give advice on corrective measures; and should provide a consulting service to their State industries. This service should be available to management or labor and discretion

should be used in seeing that the results are given to those who properly should see them. It is not in the public interest for results to be hidden from any truly interested party.

Local agencies may be desirable in the largest cities, particularly where there are many small industries, none of which can afford industrial hygienists.

All industrial hygiene agencies can provide important liaison with other agencies in the public health field such as the Veterans' Administration, Department of Agriculture, Food and Drug Administration, and others.

Competent, unbiased, public hygiene agencies that sincerely are trying to help industry provide better conditions for its workers are desirable and will receive industry's admiration and support.

Bargain

IN THE LAST few years, the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION QUARTERLY has grown rapidly, both in circulation and in the amount of reading material offered the industrial hygienist. It is the medium for the dissemination of knowledge through the exchange of experiences, and for the publication of reports of hygienic projects; it is the voice of the ASSOCIATION, and it is only $2.00 a year.

To: Mr. Howard N. Schulz
Circulation Editor, AIHA Quarterly
14th and Sheridan Rd.
North Chicago, Illinois

Please enter a subscription to the AIHA Quarterly for_____years for

Name _____

Address _____

_____

Price: $2.00 per year in the U.S.; $2.50 per year in Canada and $3.00 per year in other countries.

Check Enclosed ☐ Bill me ☐

Signature of donor _____

Address _____

_____

SCIENTIFIC BOUNDARIES *in air pollution studies*

W. C. L. HEMEON, Engineering Director
Industrial Hygiene Foundation
Mellon Institute, Pittsburgh

SCIENTIFIC INVESTIGATIONS in the field of air pollution are concerned directly with the welfare of people. Some air pollution studies can be handled almost completely on an objective basis, but in the most important areas of investigation, the subjective reactions of humans are a basic criterion to which one must constantly refer for guidance. Thus air pollution differs from most other subjects with which scientists deal; few other activities bring them into such intimate contact with the public and its attitudes.

Five major categories can be made to encompass practically all of the air pollution effects that people regard as objectionable, and a discussion of each will serve our present purpose, i.e., to delineate some of the scientific boundries in research in this field. They are: human health, sensory discomfort, toxic effects on animals and vegetation, corrosion of materials, and effects due to particulate matter.

Ill Health

ALL *responsible* allegations or speculation concerning health effects of air pollution have always referred to the respiratory system and in the area of chronic disease to the possibility of lung cancer from inhalation of tar constituents of coal smoke. The difficulties of research in this field are enormous. The illness may originate from other causes; large segments of the population also inhale tobacco smoke; the basic nature of the disease is not understood; its incidence rate is very low;—all these barriers make it appear unlikely that any sound conclusions will be drawn for a long time to come. The considerable reduction in coal smoke in various cities in recent years and the unfortunate absence of records describing smoke concentrations in earlier years constitute a further complication in the design of a complete epidemiological study.

Respiratory Irritation: When one turns to a consideration of acute assaults on the respiratory system due to irritants, the picture is less blurred. While there are no completely adequate scientific studies demonstrating a clear cut connection between smoke and illness due to respiratory irritation, it is difficult to ignore the mass of indirect evidence in the literature.

Statistical Evidence: We are prone to recall only the smog episodes of the Meuse Valley in 1930 and of Donora in 1948, in both of which industrial stack effluents were suspect. But Marsh[1] cites a series of smog periods in England which coincide with marked increases in death rates from respiratory causes and where the obvious air pollutant was coal smoke.

For example, a notorious smoke fog occurred in London in 1873 which was accompanied by a large increase in the death rate and also suffocation of a number of prize cattle on exhibition in the city at the time. In 1880, again in London, a heavy smog coincided with an increase in death rate from 27 to 48. The number of deaths during three weeks was 3000 above the average. During a five-day smog in Glasgow in 1909, deaths increased from a normal average of 35 to 233 for that week.

In London in 1922 a two-week smog was

Presented before a joint session of the American Association for the Advancement of Science and the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, at St. Louis, Missouri, December 29, 1952.

accompanied by an increase in weekly deaths from respiratory diseases. The number of deaths in the week preceding the smog was 149 and in the second week following, it was 238. In the winter of 1930-1931 in the Manchester area, the death rate from respiratory diseases in January, which had nine days of heavy smog, was 592 compared with 137 in the preceding fog-less month.

In Leeds in the winter of 1939-1940, weekly deaths from respiratory diseases increased from 17 and 23 to 76 in a week following four days of smog. Finally, in London, a dense fog occurred during the period November 26 to December 1, 1948 and was accompanied by a significant increase in mortality from the respiratory diseases, bronchitis and pneumonia, and from myocardial degeneration.[2] Even though these figures be taken to indicate a factual connection between coal smoke and mortality from respiratory diseases, it is fair to state that none of our American cities are today subject to coal smoke concentrations anywhere near approaching levels that existed in those English cities.

Scientifically designed statistical studies to elucidate the relationship between coal smoke concentrations in the atmosphere and non-fatal respiratory disorders have always suffered from the necessity of depending upon subjective reports of the people examined for the most important morbidity data.

There has recently been a notable development by which it is possible to measure effects on the breathing pattern of humans newly exposed to respiratory irritants for short periods. Amdur et al.,[3] using the Silverman pneumotachograph, demonstrated definite changes in the breathing pattern of humans exposed for a few minutes to low concentrations of sulfuric acid mist, concentrations which were far below those perceptible to the subjects themselves. This technique may provide a much needed tool for objective indication of respiratory irritation in epidemiological studies.

Irritant Constituents of Smoke: Another fundamental difficulty in the design of quantitative studies of air pollution and respiratory disorders is in lack of knowledge about the particular compounds responsible for the irritant reaction. The terms "smoke" and "air pollution" are used loosely in discussions of health effects but are, of course, meaningless in this connection.

Fig. 1.
Water soluble salts in city smoke, suggested as the irritant factor in dense smog.

In some of our own studies on this subject we conceived the viewpoint that irritation of the mucous membranes is most likely to be caused by those substances that are soluble in the aqueous fluids bathing the membrane surfaces. If this be true, then an examination of the water-soluble fraction of the airborne solids undiluted by a bulk of mineral and carbonaceous material should adduce significant information. In accordance with this conception, we have examined a number of samples of Pittsburgh soot, air-suspended solids retrieved from the plates of electric air filters.

Composition of Water-Soluble Solids: It was found that 10% to 15% of the solids are soluble in water. A microphotograph of these crystals is shown in Fig. 1. This fraction consists of 40% to 50% sulfates (expressed as SO_3), 5% to 7% chlorides, with liberal amounts of ammonia, calcium, sodium, potassium, magnesium, and a host of other metals in lesser quantities. Examination of the crystals from this water extraction by x-ray diffraction shows it to consist of ammonium sulfate in combination with the various common metals. The ammonia percentage is sufficient to account for an ammonium sulfate content of 15% to 30%, apart from the accompanying metal sulfates.

Of particular interest in the light of the rich sulfur content of the water-soluble fraction is the favorite hypothesis frequently cited concerning atmospheric oxidation of sulfur dioxide for transformation to sulfuric acid. While this probably occurs at least on a small scale, our data suggest that there is an abundance of basic substances available for its neutralization. It seems not unlikely that acidic salts of the type mentioned may be responsible for irritation of the respiratory tract and for the increase in mortality rates in the English cities previously cited.

Measurement of Atmospheric Concentrations: Knowing the particular substances that cause respiratory irritation, it next becomes necessary in a broad health study to devise techniques to measure its significant concentration in the atmosphere. This means measuring only the fraction that can penetrate to the upper respiratory tract and to the deep spaces of the lung. There are no standard or widely recognized techniques for this purpose, contrary to common opinion. Ordinary techniques for sampling airborne solids are based on a widespread fallacy that the force of gravity constitutes a positive elutriating force which effectively eliminates particles larger than those that can be inhaled, or that the chemical composition of airborne solids is the same in all size fractions. Neither of these assumptions is true. The work of Hatch et al[5] has established that particles larger than some value lying between two to 10 microns (sp. gr.=3) do not penetrate to the upper respiratory tract, and those larger than two to three microns do not penetrate to the alveoli of the lungs. If, therefore, information is desired on the inhalable mass concentration of some compound in atmospheric suspension, it must not be "contaminated" with an appreciable proportion of larger particles having a different composition.

Heterogeneous Character of Suspended Solids: The fact is that the dust suspended in city atmospheres includes a large proportion of particles too large to be inhaled into the lungs and, moreover, the composition of the larger particles is usually quite different from the inhalable fraction.

Using an air classifier, we have studied numerous bulk samples of suspended solids to determine their particle size characteristics and have found the fraction larger than 10 microns to range from 30% to 90%. Now the *number* of large particles in relation to the myriad small particles is insignificantly low, so much so that when the original mixture is viewed under the microscope by conventional methods, large particles may appear to be completely absent. When the sample is properly diluted to permit size observations and counting of the small particles, the large ones are seen only once in many fields. For this reason it is quite impractical to obtain a valid size distribution by use of the microscope.

Particles as large as 100 microns are found in temporary suspension in the air and can be aspirated into conventional air samplers unless precautions are taken to avoid them. Taking this as the top size and the bottom limit to be those visible with a powerful light microscope, e.g., 0.2 micron, it is apparent that we are dealing with a particle size range approaching one billion to one, on the basis of mass. If the smallest particles were represented as having weights of one pound, the largest particle would have the weight of a good-sized ocean liner.

It is comparatively easy to equip a sampler to reject automatically particles as large as 100 microns but rather special arrangements are necessary to eliminate those of 20 to 30 microns and larger.

We are impelled to observe, in this connection, that the use of the microscope for determination of size distribution of airborne solids has greatly impeded progress toward a better understanding in this field.

Variability in Composition: The difference in composition between the coarse and fine fractions of air-suspended solids can be illustrated by one typical sample separated by air classification and by screen. The coarse fraction was that retained on a 43-micron screen, the fine fraction was less than five to 10 microns. The fine fraction contained two times as much silica as the coarse, one third as much alumina, three times as much iron oxide, two-thirds as much sulfur trioxide, and one and a half times as much carbon.

Valid Sampling Techniques: If conventional aerosol samplers and microscopic examination are inadequate in health studies,

what measures, one may ask, are suitable for obtaining valid, quantitative data on the atmospheric concentrations of particular compounds? Microchemical techniques applied to the examination of the small particles have obvious shortcomings. Liquid sedimentation may involve a change in the state of dispersion of the solids and is, therefore, not entirely satisfactory. Ordinary air elutriators operate in accordance with sound principles, but instrument size limitations are a serious practical drawback. The cascade impactor, the conifuge and the glass helix (misnamed spiral) effect a classification of particles in accordance with size but in their conventional forms do not provide fractions of adequate size for chemical analysis; moreover, in the case of the impactor, we have some misgivings about the artificial effects of the high jet velocities on the state of dispersion of the aerosol.

In fact, there appears to be no widely recognized single instrument or technique satisfactory for these purposes. But this lack is not the basic impediment. The principal obstacle to be overcome is lack of a wide realization of the serious limitations in conventional air sampling procedures.

Sensory Discomfort, Odors

SUBSTANCES which irritate the eyes or nasal passages and those which have an odor, while superficially different, are similar in one important respect—that is, their objectionable characteristics result from direct assault on sensory nerves, creating a subjective response. Implicitly, therefore, the effect cannot be measured by any objective test. While the concentration of a particular odor could be measured by some chemical or physical test, practically it would be a quite unrewarding task to attempt development of methods for measurement of the innumerable and complex organic substances that may cause odor nuisances, particularly since it would still be necessary to relate the measurement in each case to subjective reactions of humans. When the origin of some odorous or irritating substance is obscure as in the complex of a great city, a difficult problem of some magnitude arises in the application of chemistry to the problem, as witness the large research effort devoted to the identification of eye irritation agents in Los Angeles smogs. The lack of objective criteria that could be incorporated into instrumental devices constitutes a major barrier to effective exploration of its geographical distribution during smog periods.

Toxic Effects on Animals and Vegetation

IN CONTRAST with the previous classes, research on the toxic effects on vegetation or animals of various pollutants like sulfur dioxide, fluorides, oxygenated hydrocarbons is a less complicated affair than those pertaining to toxicity in humans because it is feasible to experiment directly with the biological reactions and to refer to objective criteria. Complexities often stem from toxic effects of concentrations so minute as to tax the ingenuity of the analyst. Those toxic effects that are simulated or identical with those caused by diseases unrelated to air pollution truly approach scientific boundaries.

Particulate Matter Nuisances

FROM PRACTICAL considerations, the air pollution effects due to particulate matter are of overwhelming importance in comparison with the previously mentioned classes, because they affect a vastly greater number of people.

Haze: Aside from the health effects from inhalation which we have already discussed, all effects due to particulate matter may be described by three titles. The first of these is haze, an esthetic effect of particles while still suspended in the atmosphere, and it is useful to examine this subject in two subdivisions which are different only in degree. One is the reduction in long-distance visibility, due to relatively low concentrations of smoke or other aerosols, a common condition in our cities today; the other, due usually to dense concentrations of coal smoke, results in major obscuration of sunlight at ground level during suitable meteorological conditions. In former years this was a common condition in some cities; now it is quite rare and we propose to confine our subsequent discussion of haze to the first-named condition which is generally concerned with long-distance visibility.

Surface Soiling: The other two titles

refer to the surface effects of fuel smoke and dust at places of habitation. One may be termed "ceiling and wall soiling" and is due to extremely finely divided carbonaceous particles resulting from incomplete combustion of fuel. The other effect is that due to coarse particles (whose origin is unrelated to the efficiency of fuel combustion) which cause unsightly deposits on horizontal surfaces by gravitational deposition.

Psychological Aspects Basic: All of these effects are esthetic ones, a designation it should be noted which does not in any sense detract from their practical importance. It does remind us, however, that the subjective reaction of people to those effects constitutes the basic criterion by which one must judge the intensity of pollution, and on which measurement methods must be based.

Classifying Pollution of a Community: Gravitational dust deposition and ceiling staining are nuisances that have nothing in common except that they are caused by solid particles and they co-exist in atmospheric suspension. Their respective sizes are of two quite different magnitudes, their optical and other physical characteristics are entirely different, their origins are not the same, and they require two different and independent bases for their measurement. In consequence, the method of attacking air pollution problems in a particular locality must be designed to conform, in these terms, to the characteristics peculiar to it.

Some cities suffer from both smoke and fuel dust nuisances, others from dust alone.

The experiences of our host city of St. Louis illustrate these principles. The changes in domestic fuel effected by law several years ago resulted in drastic reduction in the emission to the atmosphere of large quantities of carbonaceous visible smoke from numberless domestic chimneys. These are the fine particles which in huge concentrations darken the sun, in lighter concentrations cause a visible outdoor haze and which coat ceilings, walls and draperies with a black scum. The rate of gravity deposition of fuel and other dust, however, was unaffected by that law[4] because they originate from different causes. Coal smoke is caused by ineffective oxidation in a fuel fire box; fuel dust, the commonest cause of dust fall, is caused, on the other hand, by buoyant action of high velocity currents of primary air passing through a fuel bed, by spreader stoker installations and by pulverized coal equipment. Smoke is prevented by arrangements for effective mixing of an adequate air supply to the fire box, whereas fuel dust can be suppressed only by dust collectors of high efficiency. Smoke is visible to all, dust is more often invisible except at its point of deposition.

Human Opinion: In a scientific approach to the air pollution problem of a community it is consequently necessary at the outset to establish the nature of the problem, in order properly to design the investigational method, or the system of control measures. In many cases the nature of the problem may be completely obvious. If not, then it is necessary to survey the subjective reaction of inhabitants either informally or by formal poll. Seldom is this problem complex enough to warrant the latter method although it was done in Los Angeles and established the fact that eye irritation is regarded by people as the primary nuisance and reduced visibility due to haze, of less importance.

Haze vs. Surface Soiling: People are prone to point the finger at visible haze as the complete evidence of air pollution. A consideration of the subjective reactions of people to haze over a city in relation to its surface-staining effects in the home raises some interesting and practical questions. Is the existence of the visible haze, per se, truly objectionable to people, or does it appear so only because it is associated with soiling effects they perceive in their homes? In communities where the haze is due to smoke, this association is a valid one, but in some localities ceiling-staining from this cause is an insignificant nuisance and dust fall a primary one. In this instance, the question assumes practical importance because dust fall at the home is not caused by the visible particles in atmospheric suspension that cause haze. If we conclude that haze is esthetically objectionable, independently of a dust fall nuisance, then two problems have been posed instead of one and the total problem becomes immeasurably more complicated.

In our own opinion the emphasis on visible haze should be almost entirely discounted by the investigator in most cities, in order to concentrate productive attention on surface effects, this on the assumption that moderate visible haze is not, in fact, the objectionable effect. If this viewpoint is not entirely valid it certainly is a practical one and in conformity with the principle that it is most logical to attack first the features of air pollution that are the most objectionable. Perhaps 25 to 50 years from now changed conditions will have resulted in quite different standards of reference.

Relative Scales of Intensity: Another instance of the subjective nature of air pollution emerges from a consideration of criteria available for evaluating its magnitude. Clearly, there can be no absolute measure of an air pollution nuisance. Coal smoke concentrations in St. Louis and Pittsburgh have been so reduced in the past few years as to be regarded as a highly satisfactory development by their inhabitants. On the other hand, newly arrived residents accustomed to cleanliness of some other different community might react unhappily to the remaining vestiges of coal smoke.

If it be thought that too much space has been devoted to the question of human attitudes, we would point out that the preceding discussion hardly begins to cover the relationship between the psychology of people and the design of objective procedures for coping with air pollution. One such aspect, for example, is concerned with the highly favorable human reaction to pollution abatement that occurs in a short time interval such as occurred in a single year in the two cities previously mentioned, as contrasted with a similar accomplishment effected so gradually over a long time period as to have been hardly perceptible to people.

The social undesirability of air pollution is widely accepted. The prime problem today in any locality is not to demonstrate this, but rather to devise and apply procedures to establish the sources on a quantitative scale and to determine costs because in the last analysis air pollution abatement is a problem in economics.

References

1. MARSH, ARNOLD: Smoke—The Problem of Coal and the Atmosphere. Faber & Faber, London, (1947).
2. LOGAN, W. P. D.: Fog and Mortality. *The Lancet*, January 8, (1949).
3. AMDUR, M. O., SILVERMAN, L., and DRINKER, P.: Inhalation of Sulfur Acid Mist by Human Subjects. *Arch. Ind. Hyg. & Occ. Med.*, 6:305, (October) 1944.
4. TUCKER, R.: The St. Louis Code and Its Operation. Air Pollution, Proc. U.S. Tech. Conf. p. 726. McGraw Hill Book Co., (1952).
5. HATCH, THEODORE F. (Private communication).

Industrial Hygiene Surveys
Toxicological & Chemical Problems

WILSON INDUSTRIAL HYGIENE
& RESEARCH LABORATORIES
330 SOUTH WELLS STREET
CHICAGO 6, ILLINOIS
Lynn D. Wilson, Ph.D., Director

Research in Instrumentation for Prevention of Industrial Health Hazards

CHapman 5-3837 CItrus 4-3727

ALBERT L. CHANEY
CHEMICAL LABORATORY
1503 East Chevy Chase Drive
Glendale 6, California

CONSULTATION and RESEARCH

AIR POLLUTION
INDUSTRIAL HYGIENE
AND
TOXICOLOGY

TRACE ELEMENT
AND
MICROCHEMICAL
ANALYSES

Effective Control of Lead Dust
in the manufacture of vinyl plastics

ALEXANDER E. GOSS, Bureau of Industrial Hygiene
Connecticut State Department of Health, Hartford
ARTHUR M. ROSS, JR., Ross & Roberts Company
Stratford, Connecticut

In the manufacture of plasticized polyvinyl chloride products, the use of powdered lead compounds creates a definite health hazard that has been difficult to control effectively. A new method of manufacture whereby these lead compounds, as well as other powdered stabilizers, colors or pigments, are (1) transferred from their original containers in an exhausted enclosure, and (2) either processed into non-dusty forms, or (3) weighed into plastic bags and sealed before entering the factory proper, provides the basis of maximum control of the dust hazard with a minimum of exhaust ventilation. This innovation in the manufacture of vinyl plastic products resulted in inhalation concentrations of lead in the workroom atmosphere well below the maximum allowable concentration as defined by state regulations. The concentration of lead in the urine of the exposed workers was within or near the range for individuals not exposed to lead dust.

IN THE manufacture of articles of commerce from plasticized polyvinyl chloride resin, the use of powdered lead compounds creates a definite health hazard which has been difficult to control effectively. This article will present the results of an investigation by the Bureau of Industrial Hygiene, Connecticut State Department of Health, at a plant producing calendered and extruded polyvinyl chloride film where the manufacturing operations differed considerably from the common practice in this industry. As a result of this change in the manufacturing procedure, the effective control of the lead dust hazard was accomplished with the use of a minimum of exhaust ventilation.

PLASTICIZED POLYVINYL chloride products comprise the following materials: resin, plasticizer, stabilizer, lubricant and usually a filler, color or pigment. Powdered lead compounds are encountered in the use of these materials as stabilizers or pigments. The most widely used stabilizers at present are lead compounds. Table I lists several of the lead compounds used as stabilizers together with a few of their chemical and physical properties. Some of the pigments may contain lead, such as chrome yellow (lead chromate). In this article only lead compounds will be considered, for if the control measures are adequate for the lead compounds, they will also be effective in the use of other materials of equal or less toxicity now used in this industry. A periodic industrial hygiene survey should be performed for all the manufacturing processes and operations. Where toxic materials are used, the necessary chemical determinations of the environmental conditions together with medical control of the workers, regardless of the method of control, should be instituted. For food packaging, lead and other toxic compounds are prohibited by law; not only must non-toxic materials be used as ingredients in the manufacture of this type

Presented before the Rubber and Plastics Division of the American Society of Mechanical Engineers, December 5, 1952, New York, New York.

of plastic film, but contamination by toxic materials used elsewhere in the plant must be avoided.

Most of the lead compounds used as stabilizers and pigments are light, fluffy, powdered materials. When being handled for weighing, blending or mixing, they create considerable dust in the workroom atmosphere. Considerable exhaust ventilation must be installed at each point of dust dissemination and sometimes additional ventilation for the general workroom area. Relying solely upon exhaust ventilation has not proved too effective in the control of the lead dust hazard.

Manufacturing Process—Common Practice

THE COMMON practice in the preparation of polyvinyl chloride composition is to weigh out all the ingredients into open metal containers. The contents of the containers are then dumped into a steam-jacketed blender and after mixing are first transferred to a Banbury mixer and subsequently to a two-roll plastic mill. Until the materials leave the mill, each operation in the process creates considerable dust every time a batch is prepared. A single plastic calendar may require from four to 25 batches per hour.

In some cases the lead stabilizer is sifted through a vibrating screen prior to use. This equipment must be completely enclosed and provided with exhaust ventilation. The dumping of the bags of lead stabilizer into the screen hopper and removing the screened material always subjects the worker to excessive concentrations of lead dust. These paper bags sometimes break in handling and the contents may be scattered over the floor. Disposal of the empty bags creates another problem, for every time the bags are handled, considerable dust is disseminated into the breathing zone of the handler. The worker who disposes of the bags and sweeps the floor is subject to high concentrations of lead dust.

When weighing out the ingredients, the worker has assembled near the weighing scale the containers of dry materials. According to the formula, the worker weighs out the correct amount of each ingredient by scooping the material from its container and placing it in a pan on a weighing scale. The weighed material is then dumped into a large metal box for transfer to the blender or Banbury mixer. The handling of the powdered materials creates dust no matter how carefully the worker may perform the operation. Since the space required for the weighing operation is large, effective exhaust ventilation is almost prohibitive in cost. In addition to the few window or wall fans usually provided for the weighing operation, the worker wears an approved dust respirator. The worker may wear the respirator during the actual weighing operation, but usually removes it before the workroom atmosphere has been cleared of dust. In most cases the workroom atmos-

TABLE I.
TYPICAL LEAD STABILIZERS FOR VINYL RESINS

TRADE NAME	TRIBASE	PLUMB-O-SIL A	PLUMB-O-SIL B	PLUMB-O-SIL C	NORMASAL	DYTHAL	DS-207	TRIBASE-E	DYPHOS
COMPOSITION	Monohydrous tribasic lead sulfate	Coprecipitated lead orthosilicate and silica gel	Coprecipitated lead orthosilicate and silica gel	Coprecipitated lead orthosilicate and silica gel	Normal lead salicylate	Dibasic lead phthalate	Dibasic lead stearate	Basic lead silicate sulfate	Dibasic lead phosphite
FORMULA	$3PbO\ PbSO_4\ H_2O$	Complex structure	Complex structure	Complex structure			$2PbO\ Pb(C_{17}H_{35}COO)_2$	Complex structure	$2PbO\cdot PbHPO_3\ \frac{1}{2}H_2O$
MOLECULAR WT	990	--	--	--	481	817	1220	663	743
BASIC LEAD CONTENT (%PbO) 1. Total 2. Safe 3. Reactive	 90.1 67.3 67.3	 60-61 30-60 30-60	 49-50 25-50 25-50	 45-48 23-48 23-48	46.0	 81.9 54.5 81.9	 54.9 31.5 54.9	 69 45.5 45.5	 90.2 60 90.2
COLOR and FORM	fine white powder	soft white powder	soft white powder	soft white powder	soft creamy white crystalline powder	fluffy yellow white crystalline powder	soft white powder (unctuous)	fine white powder	fine acicular white crystals
NON-LEAD CONTENT	8.1% - SO_3	39-40% - SiO_2	50-51% - SiO_2	38-42% - SiO_2	57.4% - salicylic acid	19.1% phthalic anhydride	46.5% stearic acid	23.9% - SiO_2 6.2% - SO_3	11.2% phosphorous acid
REFRACTIVE INDEX	2.1	1.67	1.58-1.60	1.58	1.78	1.99	1.60	2.1	2.25
SPECIFIC GRAVITY	7.1	4.1	3.3	2.9€	2.36	4.6	3.02	5.55	6.94

phere has not been cleared of the dust from the previous batch when another batch must be weighed out. At the end of the shift, the premises are covered with dust, the worker has inhaled excessive amounts of lead dust, and the protection provided by the dust respirator and the few wall or window fans has been inadequate. Management is cognizant of the health hazard due to the use of lead compounds and exhorts the worker to wear his dust respirator at all times; few workers will tolerate the discomfort of wearing a respirator over the nose and mouth for an entire working day, and this practice is neither adequate nor effective control.

The dumping of the dry ingredients into the blender or Banbury mixer disseminates additional dust into the workers' breathing zone though this operation is usually controlled by exhaust ventilation. After the Banbury, the material usually goes to a warm-up plastic mill for further mixing prior to final processing. The warm-up plastic mill has a canopy hood with exhaust ventilation to capture the vapors and dust from this operation. It is important to have adequate exhaust ventilation on the Banbury mixer and the warm-up plastic mill.

The common method for manufacturing plasticized polyvinyl chloride products using lead stabilizers and pigments presents a definite health hazard, requires considerable housekeeping, is expensive to provide effective and adequate exhaust ventilation, requires the use of a dust respirator for a major portion of the workers' work period and is not conducive to good employee-employer relations. In Table II are shown typical concentrations of lead dust in the workroom atmosphere during the above described method of manufacture.

TABLE II.
TYPICAL ATMOSPHERIC CONCENTRATIONS OF LEAD USING THE COMMON METHOD OF PRODUCTION

	Milligrams of Lead per Cubic Meter of Air
Weighing	0.36
	0.42
	2.41
	0.28
	3.22
	1.10
Blending	0.68
	0.17
	0.12
	0.34
	0.93
	1.48
Banbury	0.19
	0.23
Dry screening lead stabilizer	1.04
	2.24
	0.50
Compounding on warm-up mill	1.66
	1.08

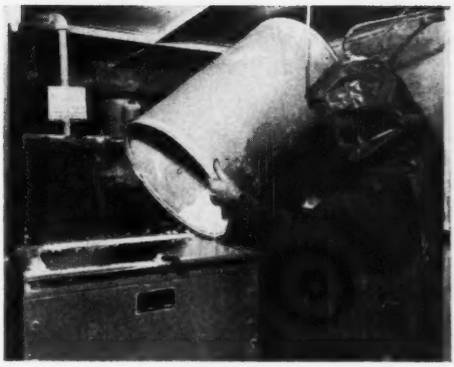


Fig. 1.
Transfer of powdered lead stabilizer in original container to blender for mixing with plasticizer. Operation is done in exhausted enclosure with worker wearing an air-supplied helmet.

Pigment Processing—New Method

THE BASIS of the new method for handling powdered lead compounds and powdered pigments lies in the following innovations. (1) All transfer of dusty materials out of their original containers is restricted to a single exhausted enclosure equipped with the necessary handling equipment, scales, air supply for the respirators, etc. (2) Whenever possible, dusty materials are processed into non-dusty pastes by mixing with plasticizers and subsequent grinding. Batches are made as large as practicable to minimize the number of weighings of powdered material. (3) When processing into paste form is not possible, dusty materials are weighed into sealable plastic bags and hermetically sealed before being brought into the factory proper.

The exhausted enclosure (Fig. 1) has a slot exhaust of 3½ inches at the floor running the width of the enclosure. The enclosure is exhausted to an exterior dust collector at the rate of 5000 CFM. The first sec-

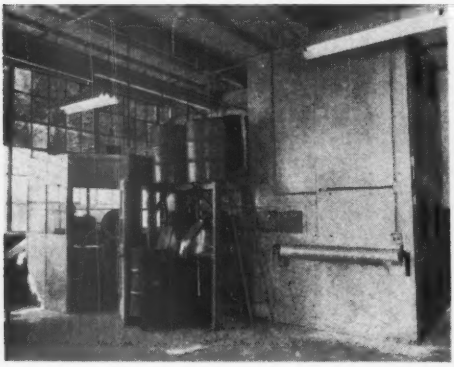


Fig. 2.
General view of exhausted enclosure with colloid mills in foreground.

tion of the enclosure is used primarily for the weighing of bulk colors into pony mixer cans in large batches. The equipment is arranged so that the air flow comes over the workman's shoulder and down toward the floor to move the dust away from his breathing zone. If the dust is toxic or objectionable, the weigher wears an air-supplied helmet. The pony mixer is equipped with a semi-circular exhaust hood so that any dust raised during mixing is carried off to the dust collector. The slurry produced in the pony mixer is then transferred to a three-roll paint mill, ground to the desired fineness, standardized and transferred to storage containers. These pastes are sufficiently stable to permit indefinite storage without settling and are delivered, accurately and neatly into plastic bags set on the pan of the weigh scale, by means of an air-driven reciprocating pump with hose and hand nozzle. The plastic bag is then sealed and delivered to the Banbury mixer floor. Color pastes too concentrated for convenient weighing may be diluted with resin in a planetary mixer and subsequently weighed into plastic bags in the conventional manner.

The second section of the enclosure uses a ribbon-blade mixer large enough to hold a full drum of lead stabilizer to eliminate the necessity of reweighing. In this section of the enclosure, ventilation is at a rate of 175 to 200 linear feet per minute. After the mixer has been loaded (Fig. 2), the calculated quantity of plasticizer is metered

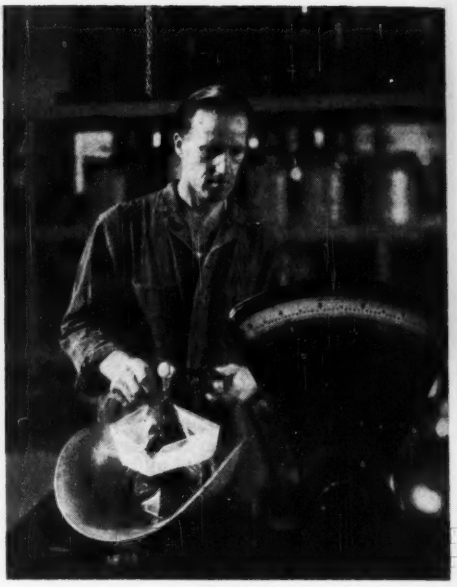


Fig. 3.
Weighing operation where lead stabilizer and color pastes are weighed and then sealed in plastic bags.

into the closed mixer and the stabilizer and plasticizer combined. The contents are then pumped into one of the two reservoirs located above a pair of colloid mills which deliver a smooth, stable and non-settling paste into portable drums. From the drum this paste is pumped to a plastic bag on the weigh scale in the same manner as the color pastes (Fig. 3). This operation eliminates any necessity for dry screening of the lead stabilizer with its attendant dust clouds.

The third section of the enclosure has two decks, the upper of which is used for storing bags of white pigments which may be used in quantities too large to permit grinding into pastes. Into this upper deck project the mouths of two storage hoppers. During the loading of bags of powdered materials into these hoppers, this upper deck is exhausted to the dust collector and the workman wears an air-supplied respirator. At the lower level, a traveling scale receives the pigment from one of the hoppers into a plastic bag mounted in a special holder on the scale pan. Flow of material

Fig. 4.
General view of color room showing paint mill, pony mixer, colloid mills, exhausted enclosure and weighing operation.

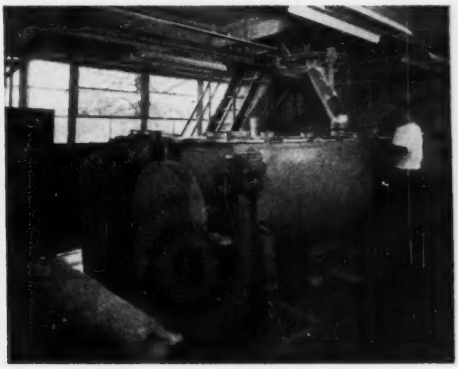


Fig. 5.
View of blenders where vinyl resin is mixed with the plasticizer.

from the hopper is regulated by a foot pedal which starts and stops the vibratory feeder to permit precise weighing without excessive dust being created. These bags are sealed within the enclosure before delivery to the Banbury floor.

Other Manufacturing Operations—New Method

IN THIS PLANT, the polyvinyl chloride resin which represents approximately two-thirds of the total weight of the materials used, is received in bags which are dumped into an air conveyor system in the warehouse proper, some two hundred feet from the manufacturing floor. The conveyor system delivers the resin to a large hopper on top of a tower designed for the compounding operations. From the hopper it is automatically fed to an enclosed sifter and then to an automatic scale which weighs and dumps the resin through an enclosed chute into covered ribbon-blade blenders (Fig. 5). Plasticizer is metered into the closed blenders at controlled temperatures, and the resulting blend is free flowing but non-dusty. Small amounts of non-toxic powdered ingredients are sometimes added to the blenders at the same time as the plasticizer. On the floor below the blenders is located the mouth of the Banbury mixer over which is a recording scale hopper fed from the blenders above by push button control. When the correct amount of blend has been run into the scale hopper, the mouth of the

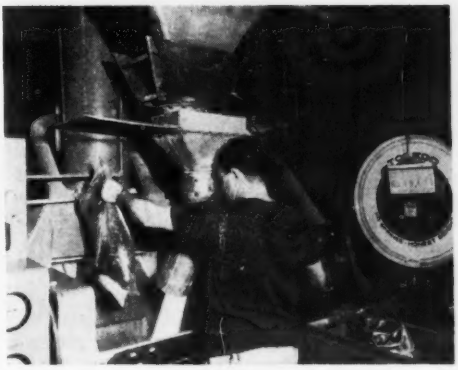


Fig. 6.
The ingredients are transferred to the Banbury. All lead compounds, fillers, colors or pigments are sealed in plastic bags.

Banbury mixer is opened and a solenoid-operated valve permits the blend to flow from the scale hopper to the Banbury. While this blend is flowing, the plastic bags containing the color pastes, lead stabilizer pastes and white pigments are dropped into the mixer by the Banbury operator (Fig. 6). A small slot exhaust at the Banbury mouth draws 250 CFM, but little dust is produced at this operation when using this process. The plastic bags do not burst until they have fallen into the Banbury cavity, and eventually the bag dissolves in the mix.

After the batch is mixed in the Banbury at the proper temperature, it is dropped onto an enclosed and exhausted conveyor

Fig. 7.
View of bottom of Banbury and exhausted conveyor to warm-up plastic mill.

Fig. 8.
View of calendar showing exhaust duct work for calendar, warm-up plastic mills and exhausted conveyor from Banbury.

and carried to the warm-up plastic mill (Fig. 7). This mill has a canopy hood with side curtains and is exhausted at a rate of 1100 CFM, giving 75 to 100 linear feet per minute in the breathing zone of the worker.

Slabs of plastic are cut from the warm-up mill and delivered to the calender on a short belt conveyor (Fig. 8). The rear end of the calender is completely enclosed and exhausted at a rate of 7500 CFM. An embossing machine running tandem with the calender has a simple canopy hood with 1400 CFM exhaust to capture any vapors that may arise. After embossing, the film is rapidly cooled by a set of large cooling drums, trimmed, passed through continuous recording gauge, then wound on paper cores and wrapped for shipment.

At this plant there is an experimental unit for the extrusion of the vinyl film. The blending of the compound for this operation is similar to the process described above and is carried out in the same equipment. Instead of going into the Banbury mixer, these blends are dropped into a portable hopper which is rolled to a point above a warm-up plastic mill and discharged through a chute onto this mill for mixing. Slabs cut from the stock on the mill are subsequently granulated in a rotating knife granulator and these granules are fed to the extruder in the customary manner. Because the extruder is being operated on an experimental basis and has not been located in its final position, it is not equipped with any special exhaust ventilation system.

Atmospheric Concentrations of Lead

THE SAMPLES of atmospheric dust were collected on one inch diameter No. 41 Whatman filter papers. Two filter papers were placed in a special holder and the workroom air sampled through the double thickness at a rate of one cubic foot per minute. The collected samples were returned to the laboratory for analysis, care being exercised to prevent contamination from extraneous sources of lead.

A polarographic method of analysis was used to determine the amount of lead in the collected samples. The procedure[1] was based on the work of Feicht, Schrenk and Brown[2] and Kolthoff and Matsuyama.[3] In outline the method consisted of digesting the filter papers in concentrated nitric acid, evaporating to dryness and then heating in a muffle furnace at 480°C for 30 minutes. A polarogram of the lead residue with KCl as the electrolyte was made, using a Sargent-Heyrovsky Polarograph Model XII. The polarographic curves for the samples were compared with lead standards following the same procedure.

The atmospheric concentrations of lead are placed in two categories, depending upon where the samples were collected:

Inhalation Concentration: The concentration of atmospheric lead, expressed as milligrams of lead per cubic meter of air, sampled at the breathing zone of the worker while performing at least one complete cycle of the operation.

Atmospheric Concentration: The concentration of lead in the workroom atmosphere,

expressed as milligrams of lead per cubic meter of air, sampled at breathing level near the potential source of dust dissemination or center of work area for a period of 30 minutes.

The maximum allowable concentration for lead in the workroom atmosphere during an eight-hour work period is 0.15 milligrams of lead per cubic meter of air.[4,5] In evaluating an exposure to lead, it is important to correlate the atmospheric concentration with the duration of exposure. It can readily be seen from the data in Table II, where the atmospheric concentrations of lead exceed the maximum allowable concentration for all operations, that the common method of production required the wearing of an approved dust respirator. The number of batches per hour, four to 25, makes it mandatory for the continuous wearing of a dust respirator. This extended period for the use of a dust respirator becomes a problem of worker discomfort, maintenance of personal protective equipment and the insistence of management that the equipment be worn at all times.

At the plant using the new method the worker wears an air-supplied helmet during the transfer of the lead stabilizer to the blender for a total work period of only 20 to 30 minutes per day. This operation is done on only one of the three shifts.

The results of this investigation are given in Table III and schematically in Figs. 9-11. The first column gives a brief description of the operation. The second column lists the approximate duration of the operation for each shift. The third column gives the atmospheric concentration of lead dust at the various operations. The last column gives the type and quantity of exhaust ventilation for each operation.

As shown by Table III, the inhalation samples were below the maximum allowable concentration. The effective control attained at this plant is shown by the low concentrations of lead for all operations, from the weighing of the ingredients to the finished product. The atmospheric concentrations were also below the maximum allowable concentrations except for the actual weighing of the lead stabilizer. This

TABLE III.
CONCENTRATIONS OF LEAD AT PLANT
USING NEW METHOD

Operation and Location	Duration of Operation per Shift (Hours)	Milligrams of Lead per Cubic Meter of Air	Type and Amount of Exhaust Ventilation
INHALATION CONCENTRATIONS			
1. Inside air-supplied helmet during the transfer of lead stabilizer to blender	0.5	0.054	Exhausted enclosure, 5,000 CFM. Worker uses an air-supplied helmet.
2. Weighing and sealing in plastic bags other lead compounds*	0.5	0.106	Exhausted enclosure, 5,000 CFM.
3. Weighing lead stabilizer mixed with the plasticizer into plastic bags	1.0	0.034	None.
4. Operation of steam-jacketed blender	8.0	0.016	None.
5. Operation of Banbury	8.0	0.009	Slot exhaust on feed hopper of Banbury, 250 CFM.
6. Operation of granulator	3.0	0.046	None.
7. No. 1 warm-up plastic mill	8.0	0.006	Canopy hood with side curtains, 1,100 CFM.
8. No. 2 warm-up plastic mill	4.0	0.015	Canopy hood with side curtains, 1,600 CFM.
ATMOSPHERIC CONCENTRATIONS			
9. Inside exhausted enclosure during the transfer of lead stabilizer to blender	0.3	0.995	Exhausted enclosure, 5,000 CFM.
10. Vicinity of colloid mill	8.0	0.019	None.
11. Vicinity of pony mixer in Color Room	8.0	0.011	Slot exhaust, 950 CFM.
12. Vicinity of weighing table	8.0	0.011	None.
13. Resin weighing room	8.0	0.023	None.
14. Steam-jacketed blender room	8.0	0.006	None.
15. Vicinity of extrusion press	8.0	0.008	None.
16. Vicinity of base of Banbury	8.0	0.027	Exhausted conveyor, 1,000 CFM.
17. Vicinity of calender and embossing rolls	8.0	0.006	Exhausted enclosure, 7,500 CFM. Canopy hood, 1,400 CFM.

*Originally this operation was performed in the compounding tower with no exhaust ventilation. Under these conditions, the atmospheric concentration was 5.700 mg. per cubic meter of air. The worker used a dust respirator during the weighing period prior to the transfer of this operation to the exhausted enclosure.

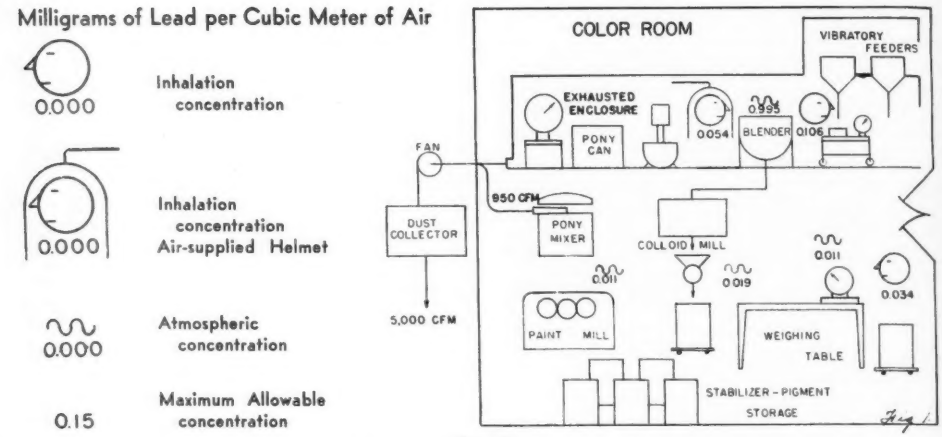


Fig. 9.
Lead concentrations at the various operations in color room and exhausted enclosure.

operation was controlled by the use of an air-supplied helmet. The use of this method of processing vinyl plastics resulted in the maximum protection to the worker from the potential lead dust hazard and the control of possible contamination of vinyl film for food packaging.

Urinary Lead Concentrations

TO FURTHER assess the degree of control obtained at this plant, samples of urine from the various workers exposed to the lead dust were quantitatively analyzed for the lead content. The samples of urine were collected in lead-free bottles on three consecutive work days, before the workers came to the plant. The method of analysis[1] was based on the work of Reed and Gant.[6]

The concentration of lead in the urine should be kept below 0.15 milligrams of lead per liter of urine for workers exposed to lead compounds.[7] Urinary leads are not an indication of lead poisoning, but if near or above 0.15 milligrams per liter, they indicate that the atmospheric concentrations of lead to which the worker is exposed are excessive. All urinary leads, as shown in Table IV, are well within the limit set for workers exposed to lead and are within or near the range for non-exposed individuals.

The urinary leads are additional evidence that the method used at this plant for the processing of vinyl products using lead stabilizers has resulted in the effective control of the lead dust hazard.

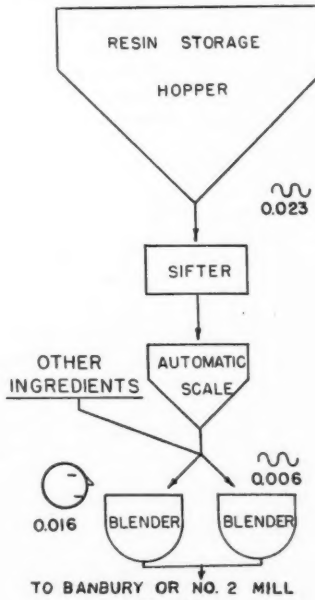


Fig. 10.
Lead concentrations at resin storage hopper and blenders.

Summary

IN THE MANUFACTURE of plasticized polyvinyl chloride products, the use of pow-

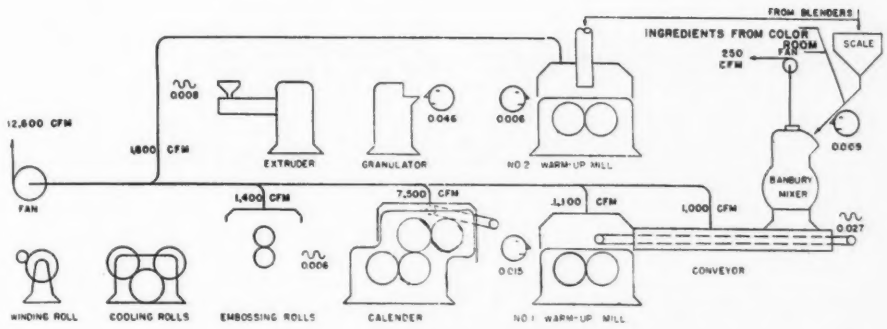


Fig. 11.
Lead concentrations at the various operations in the process for calendered and extruded vinyl film together with the exhaust ventilation.

TABLE IV.
URINARY LEAD CONCENTRATIONS OF EXPOSED WORKERS

Individual	Operation	Urinary Lead Milligrams per Liter of Urine*	
A.W.T.	Supervisor of Color Room	0.04	
		0.02	
		0.04	0.03
A.E.T.	Paint Mill Operator	0.06	
		0.025	
		0.036	0.04
M.M.	Stabilizer and Color Weigh Man	0.046	
		0.09	
		0.06	0.07
F.D.'A.	Stabilizer and Color Weigh Man	0.026	
		0.03	
		0.05	0.04
J.G.	Banbury Operator	0.02	
		0.025	
		0.024	0.02
E.T.	Premix Blender Operator	0.10	
		0.11	
		0.03	0.08

*Adjusted to a urine specific gravity of 1.024.

dered lead compounds creates a definite health hazard that has been difficult to control effectively. A new method of manufacture whereby these lead compounds, as well as other powdered stabilizers, colors or pigments, are: (1) transferred from their original containers in an exhausted enclosure, and (2) either processed into non-dusty forms, or (3) weighed into plastic bags and sealed before entering the factory proper, provides the basis of maximum control of the dust hazard with a minimum of exhaust ventilation. This innovation in the manufacture of vinyl plastic products resulted in inhalation concentrations of lead in the workroom atmosphere well below the maximum allowable concentration as defined by state regulations. The concentration of lead in the urine of the exposed workers was within or near the range for individuals not exposed to lead dusts.

Acknowledgment

THE AUTHORS express their appreciation to Rudolph K. Waldman, Bureau of Laboratories, Connecticut Department of Health, for making the urinary lead determinations.

We are especially thankful to the Ross & Roberts Company and the Bureau of Industrial Hygiene, Connecticut State Department of Health for their permission to make this information available to the plastics industry.

References

1. Laboratory Manual, Bureau of Industrial Hygiene, Connecticut State Department of Health, Hartford, (1952).
2. FEICHT, F. L., SCHRENK, H. H., and BROWN, C. E.: Determination by the Dropping-Mercury-Electrode Procedure of Lead, Cadmium, and Zinc in Samples Collected in Industrial Hygiene Studies, U.S. Bureau of Mines, R. I. 3639, Pittsburgh, Pa. (1942).
3. KOLTHOFF, I. M., and MATSUYAMA, G.: Industrial and Engineering Chemistry (Anal. Ed.). 17:615 (1945).
4. The Sanitary Code of the State of Connecticut, p. 93, Hartford, Conn. (Feb. 1951).
5. Threshold Limits. *Arch. Indust. Hyg. and Occup. Med.*, 4:398 (1951).
6. REED, G., and GANT, V. A.: *Indust. Med.*, 11:107 (1942).
7. Occupational Lead Exposure and Lead Poisoning. American Public Health Association, New York, N.Y. (1943), p. 49.

Polarographic Method

for determining chlorides in air

ALLEN GUY, Safety and Industrial Hygiene Laboratory
American Can Company, Newark, New Jersey
LYNN D. WILSON, Ph.D., Director
Wilson Industrial Hygiene & Research Laboratories, Chicago

THE DETERMINATION of chloride fumes resulting from soldering operations in can manufacture is of great importance in industrial hygiene from both the academic and practical points of view. Chloride fumes arise in these operations from the use of a commercially available soldering flux known as "roll salts," composed of approximately 55% zinc chloride and 45% ammonium chloride. The flux is placed on top of the molten solder, resulting in evolution of dense white fumes. If local ventilation is not efficient, the fumes quickly fill the manufacturing area with a heavy cloudy haze which has been shown to be composed of about 97.5% ammonium chloride, 2.5% zinc chloride, and traces of iron, tin and lead as chlorides.[1] A major nuisance results from this fume evolution in that a pungent taste and significant irritation to the upper respiratory mucosa ensue. Quantitative evaluation of the atmospheric fume level is thus necessary and serves simultaneously as a measure of the efficiency of available exhaust systems.

Until recently a modified Volhard method has been used for determination of chlorides after collection by standard impinger techniques. Two major difficulties present themselves in this procedure: (a) poor sensitivity and doubtful accuracy at low chloride concentrations, and (b) the physical cumbersomeness of handling and transporting equipment. In the first case, the uncertainty of the end-point commences at a concentration of about 20 ppm of chloride in aqueous solution and titrations become valueless below about 10 ppm. In the second case, the necessary apparatus for this one determination alone consists of 500 ml impinger tubes, a pump rated at one cfm, a flow meter, five separate chemicals, distilled water, and accessories including ringstands, clamps, burettes, beakers, wash bottles, etc., together with necessary packing boxes for transportation by car or rail. In addition to these difficulties, the impinger is not practically suited to the determination due to limited sampling rate, high heat at the solder baths, and intermittent operation of can soldering lines. As a consequence of these considerations, a search was made for a more practical method of sampling and determining chloride fumes.

In view of its versatility, accuracy, and high sensitivity the polarographic method has become of increasing interest in industrial hygiene.[2,3,4,5,6] The polarographic behavior of chlorides as anodic depolarizers was first studied by Revenda[7] and more recently by Kolthoff and Miller.[8] According to these investigators, chloride ion depolarizes the dropping mercury anode with the formation of sparingly soluble mercurous chloride, a reasonably well-defined wave resulting from the net electrode reaction,

$$2Hg + 2Cl^- = HgCl_2 + 2e \qquad (1)$$

The limiting current is dependent on the rate of chloride ion diffusion to the electrode surface and thus is proportional to the concentration of chloride ion in the body of the solution. The wave is unsymmetrical about its midpoint, the half-wave potential being given by,

$$E = 0.022 - 0.0591 \log \frac{C_{Cl^-}}{2} \qquad (2)$$

Experimental

IN ORDER to test the applicability of these considerations to the problem of ammonium chloride fume determinations, preliminary polarographic orientation experiments were conducted using potassium chloride, ammonium chloride, zinc chloride, and mixtures of zinc chloride and ammonium chloride. Final calibration curves were obtained with ammonium chloride in the concentration range from 1 ppm to 50 ppm in 0.1 N nitric acid as shown in Fig. 1. The solutions were polarographed against a saturated mercurous sulfate reference electrode ($E = +0.4$ vs. saturated calomel electrode) in an "H-cell"[9] using a voltage span of one volt and a sensitivity of 0.06 microamperes per millimeter. The mercurous sulfate half-cell was used in order to preclude chloride contamination and to provide a voltage reference more positive than the depolarization potential of chloride ion. Oxygen removal by bubbling with an inert gas is not necessary since chloride depolarization well preceeds oxygen deposition. The curves shown in Fig. 1 were obtained with a Sargent-Heyrovsky Model XXI polarograph, but exactly analogous curves were also obtained with a Sargent Model XII instrument. Figs. 2A and 2B demonstrate a most satisfactory linearity of wave height with concentration. Pertinent current and voltage data are summarized in Table I. The value of $m^{2/3}t^{1/6}$ at 0.3 v. applied EMF or + 0.1 vs the saturated calomel electrode was found to be 2.39 $mg^{2/3}$ $sec.^{-1/2}$.

Having established the feasibility of a

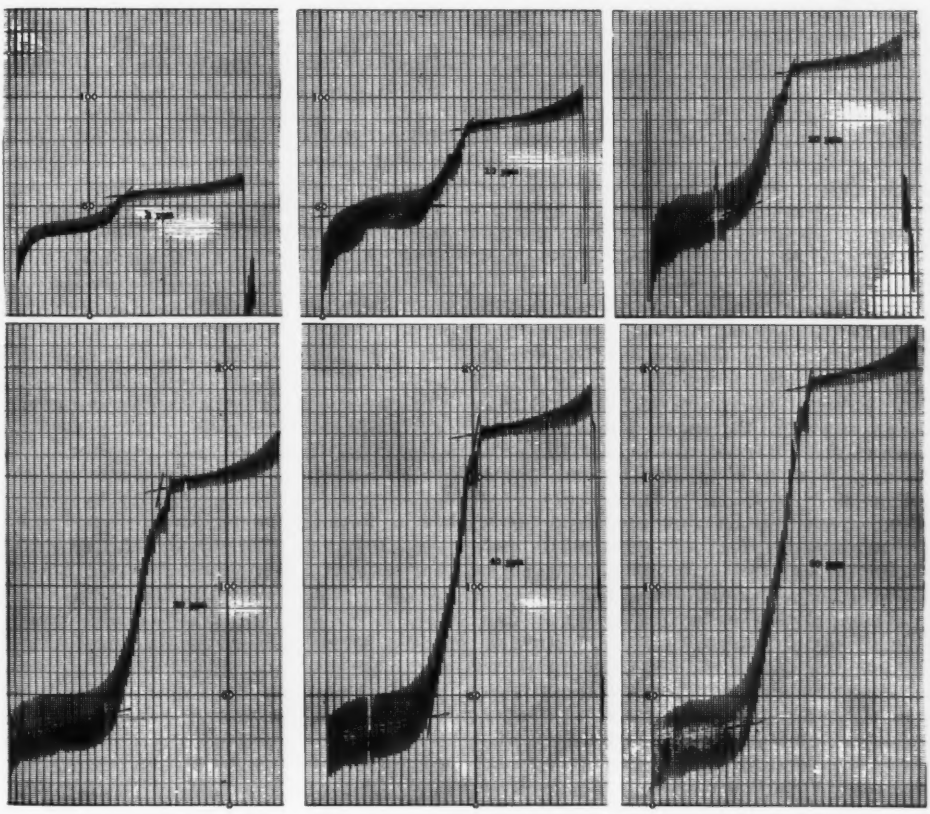


Fig. 1.

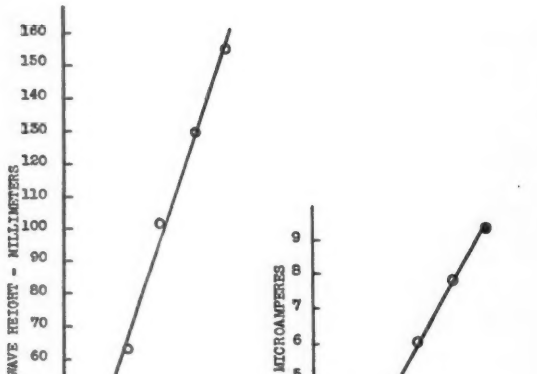


Fig. 2.

polarographic determination once the chloride sample was in solution, and accepting the well-known efficiency of the electrostatic precipitator in the sampling of fumes and dusts, it remained only to devise a suitable means of collection using the precipitator. The final solution involved lining the inside of the precipitator tube with a sheet of Munktell's No. 0 single acid-washed filter paper cut to 8.5" x 5.375" size for a snug fit. Sufficient tubes can thus be lined with filter paper so that each sample may be capped and returned to the laboratory for analysis without disturbing the precipitate. Sampling time varies with conditions, but usual convenience allows the sampling of 10 to 30 cubic feet. The sample is prepared for analysis by removing the paper and carefully placing it in a 250 ml glass-stoppered Pyrex bottle containing exactly 100 ml of 0.1 N nitric acid. On standing for several hours followed by thorough shaking, the paper becomes easily pulped. Part of the supernatant liquid is decanted into the H-cell and polarographed directly without removal of oxygen. For subsequent determinations it is only necessary to drain the previous sample through the bottom drain cock, rinse with several washes of distilled water and one or two small portions of the unknown, and refill the cell with the unknown. From the known sampling rate and the concentration as read from the calibration curve, the atmospheric chloride contamination may be readily calculated from the following expression:

$$\text{mg Cl per } M^3 = \frac{\text{ppm in solution} \times 3.53}{\text{cubic feet of air sampled}}$$

Discussion

IT HAS BEEN assumed in this study that the expected efficiency of the electrostatic precipitator is attained. No attempt has been made to compare impinger and precipitator efficiency since it is to be expected that the impinger would also collect chloride gases in addition to fumes. However, a comparison of polarographic and titrimetric procedures reveals the greater accuracy of the polarographic method as shown in Table II. It is evident from these data that titrimetric determinations at levels below about 10 ppm are definitely not to be trusted.

In addition to improvement in chloride determinations per se, the method has

TABLE I.
DIFFUSION CURRENTS AND HALF-WAVE POTENTIALS

Conc. ppm	I millimeters	I microamp	E vs sat. sulfate obs.	E vs sat. calomel obs.	E vs sat. calomel calc.
1	12	0.72	− 0.13	+ 0.27	+ 0.31
10	36	2.16	− 0.17	+ 0.23	+ 0.25
20	63	3.78	− 0.16	+ 0.24	+ 0.23
30	102	6.12	− 0.18	+ 0.22	+ 0.22
40	130	7.8	− 0.18	+ 0.22	+ 0.21
50	155	9.3	− 0.18	+ 0.22	+ 0.21

TABLE II.

Known Solution Cl ppm	Found Titrimetric	Found Polarographic
1	0.79	0.95
4	3.0	3.95
7	6.2	6.92
10	9.2	9.90
20	19.3	19.5
30	29.7	29.9
40	39.8	40.1
50	49.8	49.9

proved superior to the Volhard method in the comparison of exhaust system efficiency in these work areas. As shown in Fig. 1 it is perfectly feasible to estimate as low as 0.25 ppm at the sensitivity used, and since a sensitivity improvement factor of 20 is available, the estimation of 0.01 ppm is entirely practicable.

The calibration curves of Fig. 1 are of polarographic significance in that an anomolous step appears just below the knee of the normal diffusion plateau, losing finite identity at a concentration below about 10 ppm. It is believed that this is the first report of such behavior. The reason for its existence is not known but it appears to be independent of the associated cation and also of the indifferent electrolyte since it has been observed in both potassium nitrate and nitric acid. It has been suggested that this peculiarity might possibly be associated with a soluble complex of mercurous and chloride ions. The observed and calculated half-wave potentials are listed in Table I. The values for 30 ppm and 40 ppm which are in the vicinity of 0.001 molar agree well with that predicted by equation two and reasonably well with that found by Kolthoff and Miller.[8] The positive shift in voltage with decreasing concentration is also in accord with theory.

Summary

A METHOD for collection of chloride fumes by electrostatic precipitation using filter paper as the collecting surface is described. Subsequent pulping of the paper in 0.1 N nitric acid followed by direct polarographic measurement against a saturated mercurous sulfate reference electrode in an H-cell completes the determination. An anomolous step in the chloride wave is reported for the first time and a suggested explanation for its existence is offered. The over-all procedure is of great practical importance to the traveling industrial hygienist since it eliminates the necessity for transporting cumbersome additional equipment.

References

1. Unpublished results, Industrial Hygiene Laboratory, American Can Company.
2. GOLDMAN, F. H.: *Amer. Indus. Hyg. Assn. Quarterly*, 7:21 (1946).
3. WEBER, H. J.: *J. Ind. Hyg. & Toxic.*, 29:158 (1947).
4. WILSON, L. D.: *Amer. Indus. Hyg. Assn. Quarterly*, 10:154 (1950).
5. FEICHT, F. L. and SHRENK, E. L.: *U.S. Bur. Mines Repts.*, Investigations No. 3639 (1942).
6. SILVERMAN, L.: *Chem. Analyst*, 35:53 (1946).
7. REVENDA, J.: *Collec. Czech. Chem. Commun.*, 6:453 (1934).
8. KOLTHOFF, I. M. and MILLER, C. S.: *J. Am. Chem. Soc.*, 63:1405, 2732 (1941).
9. LINGANE, J. J. and LAITINEN, H. A.: *Ind. Eng. Chem., Anal. Ed.*, 11:504 (1939).

EMERSON VENABLE, P.E.
CHEMIST AND ENGINEER
Fellow, American Public Health Assoc.

CONSULTANT
IN
Air Pollution, Chemical Warfare and Industrial Hygiene—Research

PHONE HI-land 1-8045
6111 FIFTH AVENUE PITTSBURGH 32, PA.

INDUSTRIAL HEALTH
•
HYGIENE AND SAFETY SERVICE

6432 Cass Avenue, Detroit, Michigan
Trinity 1-4812

GORDON C. HARROLD, PH.D.
STUART F. MEEK, M.D.
AND ASSOCIATES

EAR PROTECTION

in industrial noise exposure

D. E. WHEELER, Ph.D., Los Angeles

CONSERVATION of human hearing has become a subject of increasing interest to industry. The fact that men may lose hearing acuity as a result of industrial noise exposure has been known for many years. Attention is now being given to the means whereby this loss may be reduced in extent or prevented. The following discussion deals with a particular aspect of the problem, namely, ear protection. Those interested in the general subject of an industrial hearing conservation program will find suggested reading in the attached list of references.[1,2,4]

The presence of high sound pressure levels within the ear canal constitutes a hazard which may produce, in time, a loss of hearing acuity. It is a well-founded principle to attack any hazard at its source, whenever possible. The source, in this discussion, is the industrial machinery or process which generates high level noise. The first point of attack in industrial hearing protection is, therefore, the noise source; nothing in the following discussion should be construed as a suggestion that noise reduction at its origin should be overlooked. The resources of competent acoustical engineers should be called upon as the first step in any industrial hearing conservation program. With the help of these engineers, every effort should be made to reduce environmental noise to levels which do not represent a hazard to hearing acuity.

Sometimes, however, the nature of an industrial process is such that effective acoustical treatment is difficult to apply. In other instances, ambient noise levels may still be too high after acoustical treatment has been applied. In such circumstances, the use of personal protective equipment may become necessary, just as it is now sometimes necessary in analogous instances where toxic dusts, for example, can neither be eliminated at the source or reduced to atmospheric concentrations allowable in a working environment. In the list of recognized personal protective equipment, the ear protector is an item designed to reduce the noise hazard.

Dr. Wheeler is field representative for the Sub-Committee on Noise in Industry, Committee on Hearing Conservation of the American Academy of Ophthalmology and Otolaryngology, 1136 W. 6th Street, Los Angeles 17. This paper expresses the writer's personal opinions.

Types

EAR PROTECTORS do not differ in principle from, for example, respirators and welding shields which are items of protective equipment used to reduce hazards whose effects are insidious. The performance and limitations of ear protectors, however, are not as yet well understood and it is the purpose of this article to discuss these matters.

There are three general methods of occluding the ear with devices which will attenuate air-borne sound, as follows: (1) substances inserted into the canal (insert types); (2) objects covering the orifice of the canal, usually including the auricle (muff-types); (3) fitted coverings which include the major area of the skull (helmet-types).

Combinations of the above methods may, of course, be used. Many examples of these methods of occlusion have been made commercially available for industrial use, although there has been, to date, little application of the helmet-types in general industry. The safety engineer and the industrial hygienist will need to become familiar with these various devices and to understand their function and limitations.

An Ear Protection Program

TWO OF THE FUNCTIONS of health, safety, and medical departments are: (1) to

be aware of health and safety hazards and to bring these to the attention of management; (2) to suggest protective or corrective measures. The institution of an ear protector program is similar to that of any other safety program designed to reduce or eliminate an industrial hazard. Such a program requires a "selling" job in which both management and employee are concerned.

Management needs to know that ear protection is a method of reducing the effects of a hazard, a method which may be necessary after reduction at the source has been found to be insufficiently effective or impossible to apply. To the employee, ear protectors should be "sold" in the same way as the respirator or eye shield. It is important to stress the effect of noise on hearing but avoid arousing unnecessary apprehension. In this respect, it is particularly advisable to avoid use of words such as "deaf," or "stone-deaf," and other terms which have an absolute connotation to the layman. It is highly improbable that any workman would ever become completely deaf as the result of industrial noise exposure. The meaning of deafness is somewhat specialized and the word has been dropped by The Committee on Conservation of Hearing in favor of "hearing loss" or "impaired hearing," and other terms which retain the meaning of partial loss of function. Stress should be laid upon the undesirability of any amount of preventable hearing loss, however slight. Hearing loss is *not* a normal expectation, (except in the aged or as the result of disease) and the preservation of normally acute ears is as obviously desirable as the preservation of normal vision or of all the digits on the hand.

Workmen should be taught that ear protection will not deprive them of useful hearing on the job (i.e., in the noise); these devices are not capable of producing enough loss to interfere with effective warning signals.

There is no doubt that employees will complain of discomfort when ear protection is used. This is an old story to the safety engineer and the industrial hygienist, who have had to meet the same complaint with almost every other item of personal protective equipment. No simple answer will dispose of such objections. Ear protection will require a "selling job" which probably will never be an easy one. In very high noise levels, however, employees are not always reluctant to accept some form of personal protection and may use efficient types of plugs, etc., with a little encouragement.

It is a commendable fact that workmen are frequently averse to inserting anything in the ear canal. This is a creditable accomplishment of the medical profession, the result of entirely appropriate advice to the population at large. Men who work in high noise levels, however, are representatives of the special case which does definitely require the insertion of objects into the canal. So long as these objects are *properly designed* ear protectors, and in the absence of any undesirable conditions such as an infected ear, there is no medical reason standing against their use. Most of the commercial forms of ear protectors have been designed with the care necessary to insure that their presence in the canal does not contribute any additional hazard. This point should be strongly emphasized to employees, especially where they have adopted their own favorite protectors such as screws, washers, and cartridge casings. Hard objects of this type are an invitation to serious injury in any situation where a blow on the head is a potentiality. Even if the possibility of injury is deliberately overlooked, careful observation has shown that such hard, non-conforming objects are markedly inferior in performance to correctly designed ear protectors.

On the other hand, many employees have adopted cotton waste as a form of protection. These substances are in a class with the well-known "wet handkerchief" over the nose as a respirator; in other words, not only is such protection actually ineffective, but even worse, it provides an illusion of protection which leads the employee to reject more efficient protectors.

Supply and Distribution

IN LARGE companies, ear protectors are made available in the medical department and/or the safety crib. The extent to which these sources are used depends upon the effectiveness of the safety program in force. In too many companies, the protectors are known to be available only on request by the employee. Unfortunately, in many cases, the employee never makes the request, or

if he does, he tries them, then loses or discards them.

One large company which now has an effective program of ear protection, pursues the following policy: At the beginning of each shift, a large tray of expendable protectors is brought out and the foreman or lead man sees that each employee takes a pair and applies the protectors to his ears. The tray is kept available throughout the entire shift.

Ear protectors are always small and easy to misplace. The existence of replacements directly at hand should materially assist in keeping ear protectors in the ear, the only position in which they perform any useful function.

Supervision of Use

IN CERTAIN companies, the practice is to distribute protectors through the medical department. This is a desirable step, because it naturally follows an examination of the ear canals which should disclose any condition contra-indicating the use of protectors (discharging ear, fungus, etc.). In those individuals shown by routine audiometric re-check to be "noise susceptible," the facts are noted on the medical record, and if ear protection is made mandatory, the restriction is also noted on the record. Distribution through the medical department also gives opportunity for the nurse or physician to discuss the need of ear protection with the employee. This is a natural consequence of the audiometric program, also conducted by the medical department.

The general supervision of usage of ear protectors naturally falls upon the safety and industrial hygiene group, but direct responsibility rests with foremen and leadmen who are in regular contact with the individual employee. These leaders can observe, admonish and encourage the workmen to make regular use of the protectors whenever the situation calls for protection.

In many respects, the ear protection program resembles that of visual conservation, where safety goggles are required. The men should be encouraged to keep their own protectors in order and to report any difficulty, real or imagined. The up-keep required of these devices, is of course, little more than cleaning and inspection. It would be improper to omit some instruction on the matter of sanitation. The protectors should be cleaned daily to prevent the accumulation and hardening of wax deposits. The permanent forms, usually rubber, can be washed or rinsed in water. The expendable types, such as the cotton and wax forms, should be discarded after use.

Because some of the permanent types of ear protectors give better results when combined with lubrication, instruction should be given to the workmen about ear hygiene. The water-soluble gels, such as Lubofax or K-Y Jelly are best suited. These lubricants wash out of the canal readily with water alone. Vaseline is equally effective as a lubricant but is more difficult to remove.

The occasional inspection of protectors is necessary, because some rubber compounds may deteriorate with usage and time. Men should be encouraged to replace protectors as soon as any defect is noted.

One of the persistent errors which must be overcome is the tendency of the employees to choose a small size protector, when different sizes are available. The small size may be inserted more readily and is probably more comfortable, in the opinion of the wearer, at least. Unfortunately the value of protection is thereby diminished, just as in safety goggles with lenses improperly fitted or missing. The men should be instructed to try the largest size which can be inserted in the canal. Under these conditions, an effective seal is much more likely to be obtained. It is rare to find any personal safety item which can be said to be free of any discomfort or, at least, to be less hampering than would be its absence. On no other point does the ear protector program require more selling than this one. Ear protectors are not ornaments; their fundamental purpose is the same as that of the saw-guard or the safety lens, to prevent potential loss of irreplaceable functions. When the finger is gone, when the eye is out, the function of these members and organs cannot be restored. This is likewise true of loss of hearing.

In companies where routine re-check audiometry is done, the medical department has opportunity to discuss the question of ear protection with each man as he is called back, after some experience in the use of protection.

An inherent difficulty in the supervision of use is the fact that ear protectors are not readily observable in the ear, except by close-up inspection. Exceptions to this are the muff and helmet types, which cover the external ear, thus being fairly obvious even at some distance.

Purchasing

SOME COMMERCIAL protectors are supplied in various sizes. This raises a problem for those who must decide how many of each size to order. A general rule followed by the military services which purchase large numbers of ear protectors is given below. Of the total order, the proportion of each size should be as follows:

Small	15%
Medium	70%
Large	15%

Another difficult question is the problem of what type to purchase. In the present stage of development, there are only slight differences among the various models available. Despite enthusiastic claims, the best of the currently available products falls short of the probable maximum performance to be anticipated from ear protection. A few aspects of claims which are sometimes made may be briefly reviewed:

1. Does ear protection prevent headache, irritability, body fatigue, strain, nervousness, etc.? These are laudable results, if true. Unfortunately, no carefully controlled studies exist to support these statements. Such results may or may not be obtained from ear protection, but more evidence is required than an unsupported claim.

2. Does ear protection increase the efficiency of the individual workman, thereby improving industrial output? Several studies have attempted to demonstrate this result. Unfortunately, experimental control was not satisfactory and the question is still unanswered.

3. Does ear protection allow conversation, but cut out noise? This is a complex question. The usual claims are based on a misconception of the situation in which ear protection is needed. This difficulty arises out of total unfamiliarity, misinformation, or failure of careful observation. The facts are that the best insert type ear protectors, used under ideal conditions, will produce only a moderate hearing loss, which if it were seen in a patient, would be called "border line" by the ear specialist. This leads immediately to the first, and most important, fact in the use of ear protection in industry. Men wearing ear protectors are not "deaf" in any real sense of the word.

Purpose and Function

WHEN MEN are required to work in the presence of high noise levels, their ability to hear vocal signals is impaired, and the amount of impairment is directly related to the level and frequency characteristics of the noise. People riding in trains, street cars, or buses in heavy traffic must raise their voices to be understood by others in the same vehicle. This does not mean that other people are hard of hearing: It does mean that in the presence of such noise, people with normally acute ears have an *effective* hearing loss; a loss not pathological in origin but attributable to the noise, so long as it lasts. In other words, noise at sufficiently high intensity levels interferes with vocal signals, and the phenomenon is called "masking." The individual with normal or superior hearing acuity, meaning one who can detect faint sounds, is not benefited by his acuity in the presence of noise because the noise overrides or "masks" these sounds. The principle of communication under such circumstances is that of making the vocal signal high enough to rise above the masking level. This is what one attempts in raising his voice level in the presence of noise. How successful the attempt will be depends upon the level and frequency characteristics of the particular noisy situation. There are limits to the unaided output of the human larynx.

Many industrial processes produce noise, the masking level of which exceeds the loudest shout. Those familiar with industrial situations will be unimpressed with the success of "conversation" under such circumstances. Vocal communication in the presence of high noise levels requires considerable effort. Verbal messages, therefore, are usually short; the content of the message is, in all probability, highly relevant to the attending circumstances with only a limited number of possible interpretations. Under these conditions, the "listen-

er" probably can anticipate what is going to be said.

It is also a fact that people who must communicate in the presence of high noise levels learn to read lips for the same reason that people with real hearing losses become lip-readers. This is because auditory communication has become inadequate. The suggestion of "conversation" in the presence of high noise levels is, therefore, not very realistic whether the ears are protected or not. It is also difficult to attach much meaning to the concept that ear protectors "cut-out" or "shut out" noise, with the accompanying implication that the voice signal is unimpaired. These are absolute terms, whereas the practical situation always involves a comparison of relative signal strengths. A recent survey has shown that most industrial processes produce noises whose components include the entire speech spectrum.

There is, however, a sense in which the interfering effects of noise can be reduced and the voice signal improved. It is always difficult to grasp the concept that hearing acuity under certain conditions can be improved by doing those things which ordinarily impair it. It is customary to think that covering or plugging the ears means reduced hearing acuity, a fact which is obvious if one is trying to detect faint sounds in the absence of masking noise. The reverse of this effect, however, may be observed when masking noise is present. In the presence of continuous high level noise, a man's ability to hear and understand the spoken word may be somewhat improved if he wears ear protectors. The exact reasons for this effect lie beyond the scope of this discussion, but the fact that it does occur has been verified by careful research.[3] An exception may occur when and if the voice signal falls within an interval of reduced noise and is adjusted in level to conform to the interval of relative quietness.

It is apparent from the preceding statements that ear protection, although basically a simple technique, does raise certain complex questions. Unnecessary confusion is introduced, however, by attempts to make ear protectors behave both as protective devices and aids to communication. The primary purpose of ear protection is the prevention of hearing loss as the result of exposure to noise. It is true that in many situations a secondary benefit of protection is an improvement in "on the job" communication. Whether this is important, however, depends upon the communication requirements of the particular job.

Increased interest in the effects of industrial noise exposure will probably stimulate the development of new and improved types of ear protectors. Currently, however, there are types available which seem to meet the needs of many known industrial exposures.

Summary

AS MORE consideration is given to the industrial noise problem, the greater will become the need for noise control. In those situations where engineering methods are not applicable, individual ear protection can be used to advantage. It is anticipated that ear protectors will serve the same purpose in noise exposures as respirators in dust, fume, gas and vapor exposures. Engineering control methods are considered desirable; personal protection is an additional technique useful in dealing with the problem.

There is a need for the establishment of standard testing procedures for evaluating effectiveness of ear protectors as a guide to users in various types of industrial noise exposures.

References

1. Guide for Conservation of Hearing in Industry. Sub-Committee on Noise in Industry, 1136 W. 6th Street, Los Angeles 17, California. (In press.)

2. Noise: Causes, Effects, Measurement, Costs, Control, Proceedings of the lectures presented at the In-service Training Course on The Acoustical Spectrum, University of Michigan School of Public Health and Institute of Industrial Health.

3. KRYTER, K. D.: The Effects of Noise on Man. Mono-Suppl. 1, *Journal Speech and Hearing Dis.*, 1950.

4. Proceedings of the National Noise Abatement Symposia. National Noise Abatement Council, New York 1950, 1951, 1952.

Safety Standards for Industrial Noise

STACY R. GUILD, Associate Professor of Otology
Johns Hopkins University, Baltimore

SAFETY STANDARDS, in any field, should be based on facts. To obtain facts it is necessary to make observations. In my opinion, the observational data now available do not establish enough facts either to prove or to disprove the correctness of any of the several safety standards for industrial noise that other persons have proposed or of any "educated guess." For this reason, no attempt will be made in the present communication to propose a new standard or to choose between those that have been advanced by others.

My opinion with respect to the inadequacy of the observational data now available is shared by many persons. Every author of a proposed standard has admitted, and some have even emphasized, the need of numerous observations to support the hypotheses and assumptions made. The recent publications of McGrath[1] and of Hardy[2] nicely illustrate this point, which is also stressed by Sterner[3] in his review of the diverse standards that had been proposed up to last February. The latter paper makes it possible to omit a new review of the literature and to spend the time gained in making constructive suggestions.

To be discussed are some of the gaps that exist in the knowledge needed as a proper basis for setting up a rational safety standard for industrial noise, why the gaps in knowledge have not already been filled, and how the desired facts can possibly be established.

Many persons realize keenly the important gaps that still exist and why they exist. For these persons, what follows may be boring; I can only hope that the restatements may help some to crystallize ideas on how to improve the present unsatisfactory situation.

The key question is: How tough is the human ear? The answer, as of now, has to be: We do not know, in quantitative terms, how much punishment the human ear can take without permanent impairment of its essential function, hearing. We do know that even a brief exposure to an ordinary sound causes a transient shift in the threshold of hearing, that for faint sounds the recovery time is only a fraction of a second, and that for intense sounds complete recovery may not occur for days, weeks or even, perhaps, months, after an exposure. We also know the nature of the damage done to an ear by sound so intense that complete recovery does not occur.

Furthermore, we know that the ears of some persons withstand, without injury, sounds that permanently damage other ears; i.e., that ears differ in their susceptibility to injury by noise. In addition, and an important point it is for industrial situations, we know that the longer an ear is exposed to a loud sound the more apt it is to be permanently damaged, i.e., that duration of exposure is a factor to be considered in setting up safety standards. We also know that, in general, low-pitched sounds damage ears less than do high-pitched sounds of the same physical intensity; i.e., that noises of the same total energy content may differ markedly in their effects on ears.

For this reason, any serious study of an industrial noise should include a quantitative determination of the components, by frequency bands; i.e., an analysis of the sound should be made.

Reprinted from the proceedings of the Third National Noise Abatement Symposium at Armour Research Foundation of Illinois Institute of Technology, October 10, 1952.

Need for Quantitative Data

FROM THE statements just made as to what is known, a beginner in this field might readily conclude that the information needed to set up safety standards for industrial noise is available. This would be an erroneous conclusion, because most of the information is in qualitative terms. Codes and laws and standards cannot satisfactorily be drawn up in terms of the indefinite adjectives or modifiers, such as weak, strong, loud, faint, moderately loud, many, few, much, etc.

Quantitative terms are needed, and when we attempt to specify the toughness of the human ear in definite terms we are on exceedingly shaky ground.

The beginner in the field may well ask why specific answers are not known, and comment, inwardly to himself, that good instruments for measuring hearing losses and for analyzing noises have been available for a considerable length of time. Granted. But if the beginner starts trying to control human beings he quickly learns why the toughness of the human ear has not been determined in quantitative terms. Basically, the reason is that persons cannot be treated like laboratory animals and kept under rigidly controlled conditions for long periods of time.

A few illustrative examples will suffice to make the reason obvious: (1) Workmen cannot be kept away from noise when not on the job; they may go hunting, shoot clay pigeons, etc., and they may accidentally be near explosions or other sources of intense sounds. (2) Workmen may and do change jobs. (3) Employers may and do change equipment, install more or different machines, etc.

Certainly not many men have worked in the same noise for, say, 20 years or more. Determination of the true cause of any hearing impairment found in a person who has been exposed to noise is further complicated by the fact that hearing losses are caused by conditions other than noise. Illness and aging are common causes of hearing losses that resemble those caused by noise. So, to determine the effect of a given industrial noise on hearing, it is not enough merely to test the hearing of the workmen exposed to it on the day or week of the survey and to analyze the sound. One must also determine, for each workman, a series of other factors, some of which are truly elusive. Such are, the reasons why the toughness, or ruggedness, of the human ear has not been determined in quantitative terms.

Susceptibility of the Human Ear

AT THIS TIME it may be well to digress for a moment and mention again that human ears differ in susceptibility to injury by noise. This fact, though known only quantitatively, is so well recognized that in some of the safety standards which have been proposed guesses have been made as to what percentage of persons would be injured by exposure to a noise of a certain intensity and frequency composition. Even if such guesses should prove to be correct, acceptance and use of a standard which permits even a small percentage of breakdowns to occur seems unwise, both from the medical and from the engineering viewpoints.

In engineering practice it is customary to allow a large factor of safety in setting standards for structural materials. Engineers do not wish to have even one bridge or building collapse. Certainly in setting standards for conditions under which men are to work we should not be content with situations that have only narrow margins of safety or even negative values with respect to this factor. The fact, however, that ears do differ in toughness makes it especially important, in planning standards, to know whether hearing losses found in workmen are actually due to exposure to the noise present when on the job.

With the situation that has been sketchily portrayed above, we face the practical question: How can the desired information be obtained with sufficient accuracy to prove or to disprove the correctness and the rationality of standards that have been proposed or that may in the future be advanced?

The answer, in my opinion, is: The desired information can be obtained only by the making of extensive, thorough studies in numerous and varied industrial situations; i.e., by the method of so-called field surveys. Supplementary to this answer is the following statement: Until such time as Management (capital M) and Labor (capital L) are both willing to cooperate

wholeheartedly in the making of such studies, the desired information will not be obtained.

If the matter were only of so-called "academic" interest, the "stumbling blocks" thrown in the way of carefully conducted field surveys of the effects of industrial noises would be of but little concern to anyone. As the situation actually is, as of now, both Management and Labor suffer from their stubborn attitudes. Being personally unaware of all the angles and facets of their conflicts, let us refrain from further consideration of this aspect of the problem of safety standards for industrial noise, and instead, turn to a consideration of how field surveys can be made to yield the information needed for the establishment of rational safety standards, provided Labor and Management truly cooperate with each other and with specialists in an unprejudiced effort to learn.

Field Surveys

THE FIELD SURVEYS, to be of real value for the establishment of safety standards, must of course include good analyses of the noises and good determinations of the hearing abilities of the persons who have been exposed to the noises. Both of these parts of a field survey are well described in easily available literature. Further elaboration of them therefore is not needed now, but there is a need for including some often overlooked, or neglected, procedures in all surveys from which it is hoped to draw conclusions of value with respect to safety standards for industrial noise.

The usually neglected aspects of field studies are all related to the crucially important question: Did the noise measured cause the impairment of hearing found? The answer to this question cannot be obtained by statistical treatments of the data derived from the analyses of the noise and the measurements of hearing acuity of all the workmen exposed to the noise. This method can lead only to erroneous conclusions, no matter how carefully the hearing tests themselves are made. To obtain the true answer it is essential to assess, individually for each workman who has impaired hearing, the possibility that the noise measured in the survey was not the actual cause of the impaired hearing found, and, thereafter, to include in the data treated by statistical techniques only those cases in which factors other than the noise under immediate consideration can be excluded with certainty as the cause of the impaired hearing.

To make possible the exclusion of the misleading raw data indicated above, it is essential, in my opinion, to incorporate into field surveys of the effect of industrial noise on hearing the following three features:

1. A thorough clinical examination, by a well qualified otologist, of each workman who has impaired hearing;
2. A personal history, going back to childhood, of exposures to noises and detonations other than those encountered in the present occupation; and
3. A pre-placement examination, carefully made under reproducible conditions, of the hearing of each workman.

By the combined use of the information obtainable by these three procedures, the value of the observations usually made in field surveys of the effect of industrial noise on hearing can be greatly increased. Certainly field surveys of the type indicated should afford a much better basis than is now available for the setting up of safety standards for industrial noise.

Summary

THE STATEMENTS made and the views expressed in this paper may be summarized as follows:

1. The observational data now available are inadequate as a basis for setting up safety standards for industrial noise.
2. Many things are known about the ability of the human ear to withstand injury by sounds, but they are known only in qualitative terms, not in quantitative forms needed for laws, codes, and standards.
3. Human beings cannot be kept under rigidly controlled conditions for the periods of time necessary to obtain the quantitative data desired.
4. The facts needed as a basis for setting up rational safety standards for industrial noise can be obtained, if Management and Labor will cooperate with each other and with specialists in an unprejudiced study of the problems, by the method of field surveys.

5. The field surveys, to be of real value, must include procedures to enable exclusion from consideration of those cases of impaired hearing caused by factors other than the noise associated with the occupation at the time of the survey. To accomplish this purpose, it is essential to incorporate into field surveys (1) A thorough clinical examination; (2) A personal history; and (3) A pre-placement examination.

References

1. McGRATH, R. M.: An Objective Method of Classifying Industrial Noise Environments. *Arch. Ind. Hyg. & Occ. Med.*, 5:436-444 (May) 1952.

2. HARDY, H. C.: Physical Basis of Hearing Damage and a Tentative Damage Risk Criterion for Steady-State Noise. (Paper presented at meeting of the Acoustical Society of America, May, 1952; now in press in the Arch. Ind. Hyg. & Occ. Med.)

3. STERNER, J. H.: Standards of Noise Tolerance. *Noise: Causes, Effects, Measurement, Costs, Control* (published proceedings of a symposium held at the University of Michigan in February 1952), pp. 161-166.

✦ New Standing Committees

The Board of Directors of the American Industrial Hygiene Association has given standing committee status to the newly created Standards Committee, Development Committee, Noise Committee, and a new Legislative Committee to be appointed.

The Standards Committee was established to study continuously the relationship of AIHA to other associations, particularly to the American Standards Association, and to promote the professional and technical interests of industrial hygiene in such relationships. It is expected that AIHA will now take a more active part in the work of ASA and in the consideration of standards for good industrial hygiene conditions. The Committee is under the Chairmanship of CARLTON E. BROWN, Sc.D., and the members are EDGAR C. BARNES, MELVIN W. FIRST, Ph.D., LLOYD N. HAZLETON, Ph.D., WILLIAM E. McCORMICK, ARTHUR C. STERN, and BERNARD D. TEBBENS, Sc.D.

The Development Committee consists of WARREN A. COOK, Chairman, HOWARD N. SCHULZ, WILLIAM T. McCORMICK, HERBERT T. WALWORTH, and HERBERT J. WEBER. It is charged with advising the Board of Directors upon ways for increasing the scientific and technical value of AIHA activities, and overseeing such activities.

The Noise Committee consists of CHARLES R. WILLIAMS, Ph.D., Chairman, ALLEN D. BRANDT, Sc.D., LESTER V. CRALLEY, Ph.D., EDWARD G. MEITER, Ph.D., WALTER F. SCHOLTZ, JAMES H. STERNER, M.D., and HERBERT T. WALWORTH. It is to see that AIHA remains active in various studies and programs on noise currently under way.

The Legislative Committee is to follow proposed Federal and State Legislation as it may affect industrial hygiene and advise the Board of Directors on the subject. Its first study will be that of professional licensure of registration.

Dressing Up

THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION QUARTERLY makes its 1953 appearance wearing a new cover. It was designed by R. R. ROTH of Chicago, and has received enthusiastic reception from all who have fostered its development. Any comments or opinions concerning this latest innovation will be appreciated.

—EDITOR

President's Page

Introspection

IT IS QUITE proper that the industrial hygienist pause that he might analyze his work. Indeed, periodic introspection is most necessary as a preface to understanding and determining the proper pathway toward successful advancement in any professional field. If he is to progress, he must analyze those faltering steps where his program has not had sound and fundamental development. He must recognize errors of omission as well as errors of commission. Those who indulge in such contemplation are rewarded.

The industrial hygienist is concerned with the total environment of people while at work. He may be more particularly interested in micro-chemical air sampling and analysis or his main interest and training may be in the special phase of engineering that provides environmental control to maintain worker health. Likewise, his interest may be industrial toxicology, health physics, atmospheric pollution prevention, sanitation or closely related fields. The industrial hygienist then is one having knowledge and appreciation of this general body of information on worker health preservation, although, his specific activity may be more closely directed towards one or more phases of the industrial hygiene field.

A common ground upon which these closely associated disciplines may profitably meet together with the industrial physician, industrial nurse, industrial dentist and others, is provided by the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, now in its fourteenth year. Hence the problems, programs and accomplishments of all groups may receive mutual appraisal. As a result there has developed a teamwork philosophy, without which we would be pulling at loose ends rather than together.

Industrial hygiene has now emerged as a full profession following a struggle for development and for recognition similar to that growth experience of law, medicine, engineering and other professions. The early differences in viewpoints among industrial hygienists in public health and in private industry have blended into one objective, but the opportunity for service to industry on a broad basis is not yet fully realized.

In the practice of our profession, we sometimes find it more comfortable to rely on opinion rather than on facts when we visit the factory. Ever with us is the need for more air sampling and analytical data that may verify opinion but will also give foundation to our control recommendations. Such factual data becomes worthy of industry's appropriation of money when it is determined to be necessary. The mechanics and the ritual of keeping office and the issuing of reports and statistics is important in a limited way, but it sometimes "grows like Topsy" at the expense of the industrial employee's health.

Recognized also is the fact that we have not yet brought the worker himself as close to a knowledge of what we are trying to do in industry as is desirable. We are, perhaps, as close to him as any member of the industrial health team. We can accomplish much good by expressing in his language the reasons why precautionary handling measures for hazardous substances are necessary. We can learn much from the worker by making him a part of this team. According to recent surveys, industrial employees list good working conditions as an item very close to the top of their desires.

Where the industrial hygienist, the industrial physician, and the industrial nurse become recognized as a natural part of the work place environment, there is mutual respect between the employee and those

who have his interests at heart. When an aura of mysticism is maintained concerning the effect of substances that the worker handles daily with respect to his health and well being, there may be a lack of confidence. If we have failed in some cases to sell the benefits of industrial hygiene to management, we have likewise failed to explain our program to the employee.

The need for more preventive industrial hygiene work becomes apparent. It is important that industrial hygienists sit down with groups composed of management, engineering, research, sales, production and labor, concerning plans for new processes or changes in existing processes in order to provide environmental control measures in the blueprint stage of planning before employees may be exposed to harmful substances.

Where this preventive planning has occurred, production costs have been reduced and employee illness prevented. It is important in this connection that we make more widely available to industry the needed information on precautionary handling of potentially harmful substances.

At this time we see a need for developing an industrial hygiene curriculum at undergraduate and graduate levels and for the recruitment of teachers and students to enter this field of work. Even now the establishment of fellowships in industrial hygiene is being undertaken as a partial remedy. Interest is to be developed in as many undergraduate schools as possible through voluntary lectures by industrial hygienists.

Through the work of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION'S many committees, a number of our recognized shortcomings are at this time receiving attention. The important contributions by the ASSOCIATION'S members working toward better industrial hygiene for the future is evidence that introspection pays dividends in a health professional growth.

—WILLIAM R. BRADLEY

♦ Annual Meeting

THE 1953 Industrial Health Conference will be held at Hotel Statler, Los Angeles, California, April 18 to 25, 1953. The AMERICAN INDUSTRIAL HYGIENE ASSOCIATION program starts Monday, April 20, and ends with the annual banquet and Cummings Memorial Lecture on Thursday, April 23.

The American Conference of Governmental Industrial Hygienists starts with committee meetings on Saturday, April 18, Round Table discussions on April 19 and a formal program, Monday morning April 20. Monday afternoon will be devoted to committee reports.

The detailed AIHA program is as follows:

Monday, April 20

Registration.

Industrial Hygiene Tours: Chartered buses will leave the Hotel Statler at 1:30 P.M. The tours will last approximately three and one-half hours, including travel time from the hotel and return. Members will receive an opportunity for advance registration by mail. The tours are:

1. Los Angeles County Air Pollution Control District—Demonstration of analytical methods and control devices.
2. Lever Brothers Company—Unique design adapted to the climate.
3. University of California at Los Angeles—Tour of Engineering School and New Medical School.
4. California Institute of Technology, Pasadena—Tour of seismograph and synchrotron.

Tuesday Morning, April 21

Joint Session AIHA.—ACGIH:

"The Ratios between the Various Daughter Products of Radon in Uranium Mines and How They Are Affected by Ventilation"—DUNCAN A. HOLADAY, U.S. Public Health Service, Salt Lake City, Utah.

"The Measurement of External Radiation in Uranium Mines"—Author to be announced, U.S. Public Health Service.

"The Occurrence of Radon in Non-Uranium Mines in Colorado"—P. W. JACOE, Occupational Health Service, Colorado Board of Health, Denver, Colorado.

"Industrial Hygiene Survey of Two Thorium Processing Plants"—Author to be announced, U.S. Atomic Energy Commission, New York, New York.

"Experimental Dispersion and Control of Stack Discharged Arsenic Trioxide from Gold Ore Roasting in Northern Canada"—KINGSLEY KAY, Ph.D., J. P. WINDISH, J. L. MONKMAN, J. MCKICHAN and C. R. ROSS, Industrial Health Laboratory, Department of National Health and Welfare, Ottawa, Ontario, Canada.

"Hazard Evaluation and Control Following a Spill of Forty Milligrams of Radium"—R. K. SKOW, V. V. VAN-

DIVERT, and F. R. HOLDEN, PH.D., U.S. Naval Radiological Defense Laboratory, San Francisco, California.

Local Sections Council Luncheon Meeting.

Tuesday Afternoon, April 21

General Session:

Welcome—WILLIAM R. BRADLEY, American Cyanamid Company, New York, New York, President of the AIHA.

"The Psychophysical Aspects of Industrial Hygiene Standards"—MARTIN C. WUKASCH, Industrial Hygiene Section, Texas State Department of Health, Austin.

"Industrial Hygiene for Small Industry and the Solitary Worker"—W. G. FREDRICK, Sc.D., Bureau of Industrial Hygiene, Detroit Department of Health, Detroit, Michigan.

"Occupational Hygiene in Agriculture and Small Shops"—P. H. LEACH, M.D., M.P.H., Asst. Medical Director, Richfield Oil Corporation, Los Angeles, California.

"Clinical Pulmonary Physiology II. Detection of Early Lung Functional Changes in Industrial Exposure"—H. L. MOTLEY, M.D., Cardio-Respiratory Laboratory, University of Southern California, Los Angeles, California.

"Accuracy of Microscopic Determination of Sizes of Irregularly Shaped Particles"—H. H. WATSON, Suffield Experimental Station, Ralston, Alberta, Canada.

"Experiences with Unusual Materials and Operations"—E. C. HYATT and M. F. MILLIGAN, PH.D., Health Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

Tuesday Evening, April 21

Board of Directors—Dinner Meeting.

Wednesday Morning, April 22

Joint Session AIHA—IMA:

Symposium on Noise—Co-chairmen: R. T. JOHNSTONE, M.D., Los Angeles, California and A. M. NOYES, Greater Los Angeles Chapter National Safety Council, Los Angeles, California.

"Clinical Aspects of Occupational Deafness"—HOWARD P. HOUSE, M.D.

"Noise and Audiometric Histories Resulting from Cotton Textile Operations"—J. R. COX, JR. and C. R. WILLIAMS, PH.D., Liberty Mutual Insurance Company, Boston, Massachusetts, and R. H. MANSUR, Department of Health and Welfare, State of Maine, Augusta, Maine.

"Establishment of an Industrial Hearing Conservation Program"—C. L. LLOYD, M.D., Los Angeles, California.

"What Preventive Measures Can Be Utilized—Personal Prevention"—D. E. WHEELER. "Environmental Prevention"—P. S. VENEKLASEN.

"The Need for a Center for Coordinating Data (Historical Background and the Legal Problem)"—C. R. WALMER, M.D., Industrial Hygiene Foundation of America, Pittsburgh, Pennsylvania.

Wednesday Afternoon, April 22

General Session:

"Background for the Control of Industrial Exposure to Mercury"—ROBERT A. KEHOE, M.D., Director, Department of Preventive Medicine and Industrial Health, College of Medicine, University of Cincinnati, Cincinnati, Ohio.

"Synergistic Effects of Aerosol: Particulates as Carriers of Toxic Vapors"—C. W. LABELLE, J. E. LONG, and E. E. CHRISTOFANO, Medical Laboratories, Army Chemical Center, Maryland.

Annual Business Meeting.

General Session:

"New Approaches to the Health Hazard Evaluation of Insecticides"—KINGSLEY KAY, PH.D., Industrial Health Laboratory, Department of National Health and Welfare, Ottawa, Ontario, Canada.

"Toxicity of Pyridine Derivatives with Relation to Chemical Structure"—D. W. FASSETT, M.D. and R. L. ROUNDABUSH, Laboratory of Industrial Medicine, Eastman Kodak Company, Rochester, New York.

"Buscopan, A New Antidote for Organic Phosphates"—W. B. DEICHMANN, PH.D., Albany Medical College, Union University, Albany, New York.

Thursday Morning, April 23

Concurrent Session—Air Pollution Division:

Session Arranger: BENJAMIN LINSKY, Chief, Smoke Abatement Bureau, Department of Buildings and Safety Engineering, Detroit, Michigan.

"The Los Angeles Air Pollution Prevention Program"—GORDON P. LARSON, Los Angeles County Air Pollution Control District, Los Angeles, California.

"Current Lines of Attack on the Smoke Problem in Britain"—PETER C. G. ISAAC, Public Health Engineering Laboratory, King's College, University of Durham, Newcastle upon Tyne, England (a tape recording with a full manuscript available for distribution).

"The Detroit Air Pollution Control Program"—BENJAMIN LINSKY, Chief, Smoke Abatement Bureau, Department of Buildings and Safety Engineering, Detroit, Michigan (film with live commentary).

"The Texas Approach to Air Pollution Abatement"—W. A. QUABEDEAUX, Industrial Hygiene Section, Texas State Department of Health, Austin, Texas.

Business Meeting.

Concurrent Session—Engineering Division:

Session Arranger: K. W. NELSON, Department of Hygiene, American Smelting and Refining Company, Salt Lake City, Utah; Co-chairmen to be announced.

"Ventilation for Ship Construction and Repair"—G. S. REICHENBACH, JR., Bethlehem Steel Company, Sparrows Point, Maryland.

"Crushing Plant Dust Control at the Ray Mines Division Kennecott Copper Corporation"—J. F. KNUDSEN, Industrial Hygiene Department, Kennecott Copper Corporation, Salt Lake City, Utah.

"Engineering Notes Concerning an Arsine Problem"—G. A. JOHNSON, St. Joseph Lead Company, Monaca, Pennsylvania.

"Graphic Presentation of Contaminant Characteristics Encountered in Local Exhaust Systems"—J. R. KAYSE, American Air Filter Company, Louisville, Kentucky.

"Electrostatic Effects in Fiber Filters for Aerosols"—A. T. ROSSANO, JR., U.S. Public Health Service, and LESLIE SILVERMAN, Sc.D., Harvard School of Public Health, Boston, Massachusetts.

"New Developments in Reverse Jet Filtering"—H. J. HERSEY, JR., New York, New York.

Business Meeting.

Concurrent Session—Toxicology Division:

Session Arranger: DON D. IRISH, PH.D., Dow Chemical Company, Midland, Michigan; Co-chairmen: CHARLES H. HINE, M.D., University of California Medical Center, San Francisco, California, and WILLIAM DEICHMANN, PH.D., Albany Medical College, Albany, New York.

"Malathon: A Summary of Mammalian Investigations"—L. W. HAZLETON, PH.D., and E. G. HOLLAND, Hazleton Laboratories, Falls Church, Virginia.

"Toxicological Studies of Tertiary Butyl Toluene"—C. H. HINE, M.D., University of California Medical Center, San Francisco, California.

"Toxicology of Vanadium"—J. T. MOUNTAIN, G. T. O'CONOR, L. L. LAHRMAN, N. A. TALVITIC, R. G. KEENAN and H. E. STOCKINGER, PH.D., U.S.P.H.S., Occupational Health Field Headquarters, Cincinnati, Ohio.

"The Toxicology of Monomethyl Ethers of Mono, Di and Tripropylene Glycols (dowanol 33B, 50B, 62B respectively)"—V. K. ROWE, H. C. SPENCER, PH.D., D. D. MCCOLLISTER, F. OYER, and R. L. HOLLINGSWORTH, Dow Chemical Company, Midland, Michigan.

"The Toxicology of Therman Decomposition Products of Sulfur Hexafluoride"—E. D. PALMES, PH.D., and NORTON NELSON, PH.D., Institute of Industrial Medicine, New York University-Bellevue Medical Center.

"The Toxicity of Hexachlorocyclopentadiene"—J. F.

TREON, JR., PH.D., F. P. CLEVELAND and J. CAPPEL, Kettering Laboratory of Applied Physiology, Cincinnati, Ohio.

Business Meeting.

Thursday Afternoon, April 23

Concurrent Session—Joint Session: Air Pollution and Engineering Divisions:

Session Arrangers: BENJAMIN KINSKY, Chief, Smoke Abatement Bureau, Department of Buildings and Safety Engineering, Detroit, Michigan, and K. W. NELSON, Department of Hygiene, American Smelting and Refining Company, Salt Lake City, Utah; Co-chairmen to be announced.

"A Critical Examination of Air Sampling Instrumentation and Methods"—W. T. INGRAM, Air and Water Pollution Research Section and L. DIERINGER, Institute of Industrial Medicine, New York University, New York, New York.

"The Significance of Instantaneous Peak Concentrations of Air Pollutants"—J. S. SHARRAH, Bureau of Industrial Hygiene, Pennsylvania Department of Health, Harrisburg, Pennsylvania.

"Automotive Emissions"—author to be announced, Los Angeles County Air Pollution Control District, Los Angeles, California.

"Case Histories of Collector Efficiency Measurement Studies at Ford Motor Corpany"—J. C. RADCLIFFE, and W. F. DELHEY, Industrial Health Unit, Ford Motor Company, Dearborn, Michigan.

"The Reduction of Atmospheric Pollution from Sulfuric Acid Recovery Processes"—N. W. CLAUSS, Carbide and Carbon Chemicals Company, Division of Union Carbide and Carbon Corporation, Charleston, West Virginia.

"Design Considerations for Application of Catalytic Fume Elimination"—R. J. RUFF, Catalytic Combustion Corporation, Detroit, Michigan.

Business Meeting.

Concurrent Session—Chemical and Analytical Division:

Session Arranger: WALTER H. KONN, Industrial Hygiene Department, General Motors Research Laboratories, Detroit, Michigan. Co-chairmen to be announced.

"Dust Counting by the Most Probable Number Method"—H. M. CHAPMAN, Bethlehem Steel Company, Bethlehem, Pennsylvania.

"Microscopic Observations Correlating Toxicity with the Crystal Structure of Beryllium Oxide"—GERMAIN C. CROSSMAN, Chemical Research Laboratory, Bausch and Lomb Optical Company, Rochester, New York.

"Variations in Normal Urinary Arsenic Levels"—J. L. MONKMAN, D. HENDERSON, and HAROLD MACFARLAND, Industrial Health Laboratory, Department of National Health and Welfare, Ottawa, Ontario, Canada.

"A Field Method for Determining Radon and Radon Decay Products"—E. C. EVANS III, R. K. SKOW, H. M. STEINER and J. P. WITTMAN, U.S. Naval Radiological Defense Laboratory, San Francisco, California.

"The Microdetermination of Ozone"—Bureau of Industrial Hygiene, Detroit Department of Health, Detroit, Michigan.

"Experimental Investigation of the Isolation and Identification of Benzidine and Its Derivatives in Urine"—WALTER VAN ZANT, Bureau of Adult Health, California Department of Health, Berkeley, California.

Business Meeting.

Concurrent Session—Radiation Division:

Session Arranger: ROBERT F. HAYDEN, American Cyanamid Company, Idaho Falls, Idaho; Co-chairmen: THOMAS SHIPMAN, M.D., Health Physics Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, G. V. BEARD, PH.D., Health Physics Division, U.S. Atomic Energy Commission, Idaho Falls, Idaho.

"The Concept of Maximum Permissible Dose"—A. H. DOWDY, M.D., Department of Radiology, University of California Medical Center, Los Angeles, California.

"Developments in Internal Dose Determinations"—K. Z. MORGAN, PH.D., Oak Ridge National Laboratory, Oak Ridge, Tennessee.

"Community X-Ray Hazards"—W. G. FREDRICK, SC.D., Bureau of Industrial Hygiene, Detroit Department of Health, Detroit, Michigan.

"Radiation Problems Associated with Betatrons and Synchrotrons"—S. H. CLARK, The Knolls, General Electric Company, Schenectady, New York.

"Radiation Fall-Out from Nuclear Detonations"—MERRIL EISENBUD, U.S. Atomic Energy Commission, New York, New York.

"Health Safety Considerations in the Disposal of Radioactive Wastes"—FORREST WESTERN, PH.D., U.S. Atomic Energy Commission, Washington, D.C.

Business Meeting.

Thursday Evening, April 23

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION Annual Banquet.

Donald E. Cummings Memorial Lecture—WARREN A. COOK, Zurich-American Insurance Company, Chicago, Illinois.

✦ News of Local Sections

Pittsburgh Section

ON NOVEMBER 25, 1952, the Pittsburgh Section met at the Bureau of Mines building. CHARLES D. ROBSON of the Division of Air Pollution, Bureau of Industrial Hygiene, Pennsylvania Department of Health, spoke on "In-Plant Meteorological Engineering." In his talk, MR. ROBSON discussed the type of advance planning that can be used, on the basis of meteorological studies, to control air pollution from industrial operations. Phases of meteorology and air pollution were presented.

The Section's first meeting of 1953 was held January 27. The meeting consisted of a tour of the Chemical Hygiene Department of the Carbide and Chemicals Company. Interesting points of toxicology were shown by DR. HENRY SMYTH'S staff.

The following were elected officers for 1953: GEORGE N. STEWART, President-Elect; W. E. PIROS, Secretary-Treasurer; and J. F. MORGAN, Councilor. A. M. STANG will automatically accede to the Presidency, while L. B. BERGER will serve the second year of his term as Councilor.

Northern California Section

THE ANNUAL BUSINESS MEETING of the Northern California Section was held at the Officers' Club, Alameda Naval Air Station on November 25, 1952. The election of officers and remarks from the incoming and outgoing presidents preceded the talk by LEON LEWIS, M.D., who presented a fascinating talk on his first Industrial Hygiene Survey of Iran.

RODNEY R. BEARD, M.D., Stanford University Medical School, is the new President-Elect and WESLEY J. ROBERTS, Bureau of Adult Health. Berkeley, California, has acceded to the post of Secretary-Treasurer.

The Colonial Manor was the scene of the January 27, 1953, regular meeting. DR. DONALD BIRMINGHAM, U.S.P.H.S., was the speaker of the evening. He chose as his topic: "Clinical Toxicology and Research Program."

Ohio Valley Section

AT THE OCTOBER 27 meeting of the Section, DR. O. M. DERRYBERRY, Director of the Health and Safety Branch of T.V.A., spoke on the health and safety program of the Tennessee Valley Authority.

The annual meeting was held January 28. DR. WILLIAM P. YANT, Director of Research and Development, Mine Safety Appliances Company, spoke on "Industrial Hygiene and Safety—Philosophy, Education, Research and Practice." The following were then installed as officers: EDWARD J. LARGENT, Kettering Laboratory, President; ANDREW D. HOSEY, U.S. Public Health Service, President-Elect; DR. JAMES P. HUGHES, Kettering Laboratory, Secretary-Treasurer; and HUBERT S. KLINE, Frigidaire Corporation, Executive Committee for a period of three years.

Western New York Section

THE ELEVENTH meeting of the Western New York Section was held on January 9, 1953 at the University of Rochester, Atomic Energy Project. DR. DAVID W. FASSETT of the Eastman Kodak Company, demonstrated a rapid technique for the determination of carbon monoxide in blood, using the commonly available M.S.A. carbon monoxide detector. Industrial applications of this technique were discussed during the course of the paper. THOMAS MERCER of the Atomic Energy Project, University of Rochester, described experiments establishing the efficiency of the electrostatic precipitator in removing a sodium chloride aerosol from the atmosphere. The data reported in this paper are the first quantitative evaluation of electrostatic precipitator efficiency by means of radioactive techniques. The program was concluded by the showing of the indoctrination film used by the University of Rochester Atomic Energy Project to introduce students in the Radiological Physics program to that portion dealing with industrial hygiene.

On January 31, the Section met at the Bausch and Lomb Optical Company. An extensive program was presented. "Microscopy of Toxic Dusts Including Forms of Free Silica and Beryllium Oxide" by GERMAIN CROSSMAN was illustrated in its entirety by Kodachrome and black and white lantern slides and demonstrations. Following this lecture, Dosimeter Glass was demonstrated by DR. N. KREIDL. A piece of this glass detects the presence of atomic radiation in varying degrees and makes it possible to prescribe correct medical treatment for the wearer in case of exposure. Next on the program were two sound movies: "To Greater Vision" and "Phase Microscopy." Casting and pouring of optical glass in the Chemical Research Laboratory were demonstrated. A few dust samples augmented the microscope demonstrations. The program was concluded with a luncheon through the courtesy of Bausch and Lomb Optical Company. WILLIAM McQUILKIN, Treasurer of Bausch and Lomb, gave a brief talk at this time.

Philadelphia Section

THE SEVENTH Annual Tri-Section Meeting was held at the John Bartram Hotel January 30, 1953. This conference is sponsored by the New Jersey, Metropolitan New York and Philadelphia Sections. The afternoon session began with a talk by ARTHUR C. STERN, New York State Department of Labor. MR. STERN'S subject, "Exposure to Fluoride Dust in the Fluoridation of Public Water Supplies" proved as interesting as it is timely. Four more highly informative lectures followed. These were: "The Use of Liquid Gas Scrubbers for Controlling Asphalt Plant Nuisances" delivered by GEORGE A. MAU, Johnson-Marsh Company; "Psychogenic Aspects of Industrial Dermatoses" by DR. JOSEPH V. KLAUDER, Dermatologist; "Use of Thoriated Tungsten Electrodes in Inert Gas Shielded Arc Welding" by A. J. BRESLIN, Atomic Energy Commission; and "Factors in Industrial Fatigue" by DR. ALLAN J. FLEMING, Assistant Medical Director, E. I. duPont Company. A social hour and dinner preceded the address, "Industrial Hygiene Analyzes Itself," by W. R. BRADLEY, President of the AIHA.

Michigan Section

GEORGE D. CLAYTON and PAUL M. GIEVER were the speakers at the January 14 meeting of the Michigan Section. As members of the United States Section, Technical Advisory

Board, International Joint Commission, they discussed the Detroit-Windsor Air Pollution Study which has been in progress since 1950. In addition to describing the instruments employed and results obtained to date in this study, MR. CLAYTON also included data from the recent period of heavy atmospheric pollution in London.

Western Michigan Section

THE JOINT Meeting of the Battle Creek Safety Club and Western Michigan Section of the AIHA was held January 12, 1953. JOHN SOET, Acting Director, Division of Industrial Health, Michigan Department of Health, addressed the group on "Just What is Industrial Hygiene?"

The Western Michigan Section will participate in the Michigan Safety Conference to be held in Grand Rapids on April 21, 22 and 23. The plans for the Section's contribution to the conference are still tentative, but a series of three talks is being considered. These would be: "Noise Control in Industry" by IRVING DAVIS, Division of Industrial Health; "Toxic Compounds—Hidden Death in Containers" (no speaker announced); and "General Ventilation" by K. E. ROBINSON, Division of Industrial Health.

Chicago Section

DECEMBER 3, 1952, ELGIN D. SALLEE, Supervisor of Industrial Hygiene, American Can Company, spoke to the Chicago Section on "Important Features in Teaching Industrial Hygiene to Plant Employees." This was the Past President's address and MR. SALLEE'S topic was a timely and stimulating subject for the occasion.

DR. O. T. MALLERY, JR. addressed the group at the January 7 meeting. His subject, "The Industrial Health Team: A Self Analysis," was an extensive discussion of the individual role and the team approach of the industrial physician, the industrial hygienist, the industrial nurse, the industrial safetyman, the industrial dentist, the foreman, and the individual worker in achieving occupational health. In addition, DR. MALLERY related the discussion to the problems in the small plant as well as in large industrial firms.

At the Joint Meeting of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, Chicago Section, and the American Society of Safety Engineers, Greater Chicago Chapter, held February 4, 1953, HALE J. SABINE, Chief Acoustical Engineer, The Celotex Corporation, delivered a talk on "Industrial Noise Control." The interesting discussion was augmented with slides and tape records of various types and kinds of noises. The continued and mounting interest in Industrial Hygiene in the Chicago area is perhaps best reflected by the fact that the membership in the Section is rapidly approaching the two hundred and fifty mark.

Washington-Baltimore Section

DR. DONALD BIRMINGHAM, Chief Dermatologist of the Division of Occupational Health, U.S. Public Health Service, told a meeting of the Washington-Baltimore Section on December 3, 1952, that skin diseases still represent the Number One problem in industry. He discussed the principal causes of dermatitis and possible controls. Dr. Birmingham assured the audience that "Only a small percentage of skin disease in industry is due to allergy." He further stated that "The essence of the prevention of skin disease is cleanliness, carried out through personal and environmental hygiene."

Industrial hygiene experiences in the "three worlds" of Peru were described by VICTORIA TRASKO of the Division of Occupational Health, U.S. Public Health Service, before the February 17 meeting at the Naval Gun Factory. MISS TRASKO spent eight months in South America, under the auspices of the Institute of Inter-American Affairs, helping the Peruvian government study the health problems of its workers. In the course of the survey, hundreds of plants were visited. Illustrating her talk with a series of colored slides, she showed the group that the project meant going everywhere that industry was to be found—crossing the desert, climbing the high Sierras, and trekking through dense jungle. With a team of physicians and engineers, MISS TRASKO covered numerous industrial establishments. Only the mines were closed to her because of an age-old superstition prohibiting women. She reported that among the major occupational diseases encountered were silicosis in the mining region, dermatitis in the lumber mills and agricultural processing plants, and bagassosis in the sugar cane industry. Her official report on the health findings of the survey has been translated into Spanish and has been submitted to the Peruvian Ministry of Health. "Peru and other South American countries are greatly concerned about the health of their workers," MISS TRASKO told the group. "They recognize that disease saps the workers of vitality and productivity, and they are eager to take all possible steps to control occupational health hazards and to raise the general health level of their people. While many of these countries lack our facilities, they want to move forward as rapidly as possible with sanitation and health programs."

North Texas Section

THE NORTH TEXAS Section, new to the membership of the Association, was formally approved by the National Board of Directors in July, 1952, following the section's formation in February of that year. Beginning with January, 1953, meetings are planned on the third Monday of every other month.

There is a present membership of 18, seven of whom are associate members. Charter members are: HENRY T. HERNDON (Chairman), Industrial Hygiene Engineer, Texas Employers' Insurance Association and Employers Casualty Company, Dallas; MORTON F. MASON (Chairman-Elect), Toxicologist, Southwestern Medical College and Parkland Hospital, Dallas; JOHN W. LANIUS, M.D. (Secretary-Treasurer), Dallas; SIDNEY GALT, M.D.; D. P. LAUGENOUR, M.D.; GEORGE LAUNEY, M.D.; FRANK J. ALTICK, M.D.; CHARLES J. PATNERNOSTRO, M.D.; JAMES K. ROSS, M.D.; GEORGE M. KINTZ, Chief of Accident and Health, Division of Region Six, U.S. Bureau of Mines, Dallas and CHARLES W. REED, Analyst, Industrial Hygiene Section, Texas Employers' Insurance Association and Employers Casualty Company, Dallas.

To date six meetings have been held, including one co-meeting in September of 1952 with the Gulf Coast Section at Houston. At the other meetings the speakers and their subjects were: April, 1952—DICK DICKERSON, District Judge, Dallas County, "Courtroom Conduct of Expert Witnesses." June, 1952—J. W. HAMMOND, Industrial Hygienist, Humble Oil & Refining Company, Medical Division, Houston, "Industrial Hygiene Activities of the Humble Oil & Refining Company." November, 1952—J. B. HOWELL, M.D., Dermatologist, Dallas, "Industrial Dermatoses." January, 1953—HENRY T. HERNDON, "Air Pollution."

Utah Section

DUE TO an increased interest in the problem of air pollution, on the part of the farmers, residents near industrial areas, the Utah State Department of Health and some industries in Utah, the Utah Section presented a panel discussion on "Air Pollution Problems of Utah" at the January 28 meeting.

Guest speakers on the panel were DR. GEORGE A. SPENDLOVE, State Commissioner of Public Health; DR. DELBERT GREENWOOD, Professor of Chemistry, Utah State Agricultural College; PROFESSOR VERN HALES, Meteorology Department of the University of Utah; DR. GEORGE HILL, formerly with American Smelting & Refining Company; and W. L. LATSHAW, Director of Agriculture Department of U.S. Smelting & Refining Company. E. ELBRIDGE MORRILL, JR., member of the AIHA, Utah Section, was the moderator for the Panel. The Fraternity of XI, University of Utah, was invited to the meeting because of their mutual interest in the scheduled program.

It was brought out by DR. HILL that the A.S.&R. Company had been conducting research studies for many years, particularly on sulfur dioxide stack effluents. In addition to the voluminous amount of data collected, several engineering controls have been designed and installed. DR. HILL emphasized that air pollution is not a problem confined to industry alone. There are many domestic sources of air pollution—from our homes, from use of our automobiles, etc. It must be realized that there is a mutual need for public interest and public cooperation in this matter. DR. GREENWOOD discussed the effects of fluorides on cattle and vegetation (crops and plants). He presented representative specimens to demonstrate the findings of the studies he has conducted in Utah during the past year. Dr. Greenwood has spent the past 20 years studying the effects of fluorides on cattle and plant life in various areas of the U.S. The large attendance of approximately 100 persons indicated that there is an extensive interest in air pollution in Utah.

Northern California Section

JANUARY 27, the Section met at the Colonial Manor, San Francisco. Dinner followed the social hour with thirty-one members and guests in attendance. HENRY R. JAMES was chosen as Chairman of the newly selected membership committee, including LAWRENCE L. SCHMELZER and GEORGE A. SHERMAN. President OSCAR SOBOL appointed FRED R. INGRAM Chairman, with DR. CHARLES HINE, DR. LEON LEWIS and DR. CHRISTINE EINERT as a committee, to furnish articles for publication in *California's Health*, *California Safety News*, or other publications for getting information to the general public on subjects such as carbon tetrachloride.

The speaker of the evening, DR. DONALD BIRMINGHAM, Chief of the Clinical Section, Occupational Health Field Headquarters, U.S. Public Health Service, Cincinnati, Ohio, explained the organization of the Division as follows:

1. Washington Branches: (a) Program Planning and (b) State Aid.

2. Field Headquarters, Cincinnati: (a) Clinical Section; (b) Toxicological Section; (c) Engineering Section.

He then discussed the various activities of the three sections at Cincinnati with respect to field studies and research.

DR. LEWIS CRALLEY, who is in charge of the Salt Lake City office of the U.S.P.H.S. was also present and was called upon to answer

some questions. The question period indicated the interest of the group in the program of the U.S.P.H.S. in the field of Occupational Health.

At the Executive Committee meeting of January 27, a letter from DR. BERNARD D. TEBBINS called the Section's attention to the fact that, (to quote from an announcement of President Sproul of the University of California) "arrangements have been concluded to hold the 121st meeting of the American Association for the Advancement of Science, on December 26-31, 1954, on the Berkeley Campus." DR. TEBBINS wished the membership to be made aware of this meeting in which the AIHA members will be expected to play a part.

◆ Classified

Positions Available

Engineers—(2) with strong industrial background in the design and installation of dust control, heating and ventilating equipment. Salary, $9,000-10,000 and $6,000-8,000. Large New Jersey corporation.

Industrial hygienist—for development and implementation of program in chemical plant. Starting salary $6,200. Address: Dr. G. H. Collings, Chief, Occupational Health Branch, Tennessee Valley Authority, Wilson Dam, Alabama.

Industrial hygiene or atmospheric pollution engineer—preferably one qualified for both fields. Civil service regulations require registered professional chemical engineer. Address: Dr. H. Gardner Bourne, Jr., Acting Chief, Division of Industrial Hygiene, Ohio Department of Health, Columbus 15, Ohio.

Industrial hygiene engineer—25 to 35 with degree in chemistry, chemical engineering, mechanical engineering or equivalent. Address: D. P. O'Neil, Argonne National Laboratory, P.O. Box 5207, Chicago 80, Illinois.

Industrial hygienist for chemical company, Middle West. Experienced man in early 30's capable of independent work in conducting surveys including sampling and analysis. One-third to one-fourth of time travelling. Salary range $500 to $600.

Junior ($4,800) and senior ($6,000-7,500) industrial hygiene engineers—State Board of Health, Helena, Montana. Address: Dr. G. D. Carlyle Thompson, Executive Officer.

Project leader—for research on particles and aerosols. GS Civil Service rating, initial salary $7,040. Also need physicists, chemical engineers, physical chemists and technicians. Address: Dr. Carlton E. Brown, Chemical Corps Biological Laboratories, Camp Detrick, Frederick, Maryland.

Industrial hygienist or chemist—Three years experience or graduate degree. Starting salary $5,060. Address: Medical Department, U.S. Naval Shipyard, Portsmouth, Virginia.

Chief, Bureau of Smoke Abatement—$6,378-8,412. Must be an engineer qualified by technical training in the theory and practice of heating and power operation or either one or both and fuel burning. He should also be experienced in and thoroughly familiar with the design, construction and operation of boilers and furnaces and in the theory and practice of smoke prevention and abatement, and must be registered professional engineer in the State of Ohio. He shall have charge of the enforcement of all ordinances pertaining to smoke regulation and inaugurate execution of educational plans for securing the cooperation of the public in the reduction of the emission of smoke; of the examination of all applications and plans for the installation and use of combustion devices within the jurisdiction of the Division of Air Pollution Control; the inspection of the installation according to the plans approved of all combustion devices within the jurisdiction of the Division of Air Pollution Control; the prevention and abatement of smoke, fumes and fly ash as more fully detailed in the Air Pollution Code, and shall exercise general supervision of the Bureau of Smoke Abatement.

Chief, Bureau of Industrial Nuisances—$6,378-8,412. Same general qualifications as listed in the preceding item. That is, must be eligible for registration as a professional engineer in the State of Ohio, but work will be devoted to control of industrial fumes and wastes other than from combustion devices.

Chief, Bureau of Industrial Hygiene—$6,378-8,412. Must be trained in sanitary engineering with a knowledge of occupational hazards and diseases and their control. Will be charged with the enforcement of code provisions pertaining to health of workers within enclosures.

Chemist—$4,992-6,378. To assist the Chief of the Bureau of Industrial Nuisances in field determinations of air contaminants and enforcement of the air pollution code from sources other than combustion.

Junior Mechanical Engineer—$3,768-4,338. Should be a recent engineering graduate and will be assigned to assist in enforcement of air pollution code with relation to combustion equipment.

Assistant Mechanical Engineer—$4,338-4,992. To assist Chief of Bureau of Industrial Nuisances in analyzing industrial waste problems and evaluation methods of control.

Personnel Available

The AIHA Personnel Placement Committee has qualified applicants for all phases of industrial hygiene. For additional information on positions or applicants write: Frederick S. Mallette, Chairman, AIHA Personnel Placement Committee, c/o American Society of Mechanical Engineers, 29 West 39th Street, New York 18, New York.